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No. 43

(Geographic, Population, Weather, And Vegetation Background Information on Brazil)

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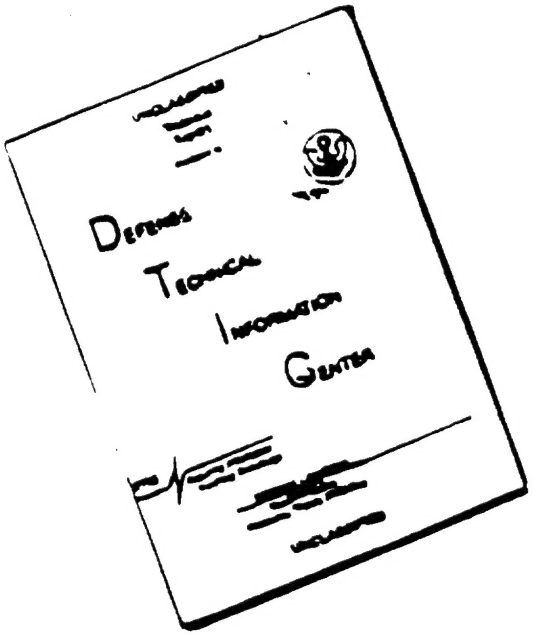

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ECONOMIC AND GEOGRAPHIC
TRANSLATIONS ON LATIN AMERICA

No. 43

GEOGRAPHIC, POPULATION, WEATHER, AND VEGETATION BACKGROUND INFORMATION ON BRAZIL

[Following is the translation of excerpts from the Portuguese-language periodical Boletim Geografico (Geographic Bulletin), Rio de Janeiro, 1965; issue numbers, dates, page numbers, and author's names are given with individual article headings.]

END

[No 184, January-February 1965, pp 3-6]

Rio de Janeiro and Its Suburbs

Paul Argue

(Translation from French into Portuguese by Olga Buarque de Lima)

(Source: Les Cahiers d'Outre-Mer [Overseas Notebooks], Vol 17, No 55, Jan-Mar 1961, pp 100-105)

Rio de Janeiro and the surrounding region differ from the majority of the great metropolises by virtue of the diversified character of their terrain formation. The most impressive contrast here is the one represented by lowland consisting of formerly swampy plains, gently rolling hills, and the rather powerfully rising mountain ranges with their abrupt slopes; two of these mountain ranges exceed an elevation of 1,000 m -- the massif of Pedra Branca (1,024 m) and the massif of Tijuca (1,021 m); right near by, constituting a part of the serra do Mar [ocean mountain range], we can see the Mendanha mountain range; then we come to the mountain ranges of Quitungo, Capoeira Grande, etc, with somewhat lower elevations. The site of the city itself is cut in half by the Carioca massif, a spur of the Tijuca mountain range; it is dotted with many low hills [hillocks].

The Portuguese found a number of strategic locations among these hillocks which dominate the gulf; however, starting with the 16th century, the people there began to live in the valleys and along the swampy edges of the bay; this had become possible as a result of the drainage projects and the dirt-filling operations carried out by slaves. Later on, a number of hillocks were levelled off (Santo Antonio, Castelo) and this created new space for housing construction. Thus the city gradually grew all around, rather tenaciously digging into the mountain massifs. This explains its rather discontinuous character; the city is broken up into borroughs as a

result of the presence of valleys and lowland stretches along the ocean beach. Copacabana is connected to the rest of the city, on the one hand, by tunnels and, on the other hand, by a very narrow passage between the hillocks and the beach. However, the population growth here required the occupation of the hillocks and this area became a proletarian development -- the so-called "favelas" [slums]. But not even the mountains could prevent the expansion of the city; in certain borroughs, such as Leblon, construction did not stop until the buildings had reached the abrupt and rocky walls of the mountains; slum sections were built amid rock areas, as in the case of Sao Diogo. In Leblon we find beautiful homes in a part of the city that is very difficult to reach. This considerable growth -- the entire area of greater Rio de Janeiro numbers more than 3 million inhabitants -- can be explained in the light of the activities of the port of this city; initially, this port was used for the shipment of products from the mines and then from the farmland of the lowland sections along the river; this included sugar cane, coffee, and, most recently, oranges and bananas. This situation is also explained by the industrial function of the city and the port and finally by the fact that this city is the political capital of the country and has been playing this role from 1763 until recent years. Although Brasilia has replaced Rio de Janeiro as the center of government, it could not challenge the economic preponderance of that city which not even Sao Paulo could properly challenge.

Rio de Janeiro has gone through a considerable period of expansion; it gobbled up the entire state of Guanabara, the former Federal District, and annexed the small population nuclei grouped around a church and a store. Factors in this integration, essentially, were the lines of communication. From the very beginning, the waterways, along which embarcation and debarcation points were established, led to the construction of roads linking these points to the nearby zones; but even the big and important ones, such as Iguacu or Maje did not become real cities as such; they remained simple, large-scale supply stations with warehouses and so on; the majority of the population consisted of highly mobile individuals, cattle men, sheep herders, coffee brokers, and so on; the stable portion of the population consisted of merchants, artisans (blacksmiths, shoemakers). The railroads of course made these large-scale warehousing stations superfluous and more or less disorganized the situation. The lowland section was largely abandoned and once again became a swamp; vigorous action has been taken to correct this situation ever since 1963. Thus, Iguacu became a ghost town; its original function as the municipal seat was taken over by the station at Maxambomba, an old sugar mill, now called Nova Iguacu and situated in a less unhealthy zone, in the vicinity of the big Central do Brasil railroad line.

This integration process took place spontaneously around railroad stations and along highways. On the other hand, the big properties -- this being the predominant form of land ownership here -- became unproductive; they were then broken up into small lots, very often in a highly confused fashion and the lots were then not always completely occupied. Industry found cheap land, abundant water, and power resources in the water bodies coming down from the mountain ranges. The manpower is not recruited locally;

there is a very active commuter movement between here and the city of Rio de Janeiro. A number of functionaries, going all the way up to the rank of prefect [mayor] and of course professional men do not live where they work; twice or three times a week they come in from Rio or from Niteroi. The small and old centers are progressively being incorporated into the big city; Nova Iguacu today marks the limit of urban growth. The population density decreases as we move further away from the center; this enables us to draw a kind of urban pioneering boundary: the density, in the townships of Nilopolis and Sao Joao de Meriti is between 4,000 and 3,000 inhabitants per sq km; in the district of Nova Iguacu it is only 447 and then it drops to 45-90 in the districts situated immediately to the north.

Around the bay of Guanabara we can distinguish a number of concentric zones.

1. The center or city [downtown]. This is the old city which continues to exist because of the communication facilities, the influence of the port -- which the first skyscraper, the A Noite [Evening] building was erected -- as well as the government agencies in the old buildings, such as the postoffice building which now is housed in the old palace of the viceroys. This zone has changed temendously over the past 30 or 40 years; the old houses have been torn down and replaced with 20-story buildings; here we also have broad avenues, such as the Rio Branco Avenue, the main artery in this city. However, we can still find some little old streets running along the hillocks; here we can find small shops and stores, artisans, and the homes of people with modest resources. Although the major portion of the center [downtown] is inhabited by workers, we can also find banks, motion picture theaters (Cinelandia) concentrated here; in the place where Castelo hillock used to stand -- it has been razed -- we now find embassies, government agencies, and high-level government offices all of whom were very reluctant to leave this place and go to Brasilia; here we also have tourist agencies, airline company offices and so on; but we must point out that Castelo hill constitutes the exception here.

2. Peripheral zone. Because of the relief, this is a rather broken-up zone; here we find mostly residential sections which have been developing here ever since the beginning of the 20th century. Industries that used to be based here have moved on toward the valley bottoms where there is abundant water; as a result, proletarian sections could be built in their vicinities, in blocks consisting of small houses. At the same time, however, well-appointed homes were built for the bourgeoisie, which was now replacing the aristocracy, along the old-class mansions and office buildings. The communications system of course helped in the settlement of the area because the people could now afford to live further and further away from their place of employment; the first donkey-drawn streetcar line was built toward Sao Cristovao in 1870 and after that communication facilities kept multiplying and were constantly modernized.

One very noteworthy fact here is the progress in the southern zone, especially the area of Copacabana; this progress was launched the moment the

area became accessible after the opening of the tunnel; today this is a very heavily settled area and all of the buildings are very tall here. The zones around the massif of Carioca, in particular, were occupied by the middle class (Flamengo, in the southern part, Tijuca in the northern part). These sections of the city had a rather commercial organization which eliminated the need for long and rather time consuming and difficult trips to the center of the city; here we find doctor's offices, hospitals, and maternity wards. We note a tendency toward the drop in the social level, something which is expressed by the appearance of slum sections along the hillside.

3. The surburban zone. This turned out to be the primary area for the establishment of industries which were attracted here by the cheap land, by lower taxes, and by less crowded transportation routes. Urban growth here came in a rather tentacular form, along the axes of transportation, along railroad lines and streetcar lines, which reached Madureira. The principal centers were established to the north of the massif of Tijuca and Pedra Branca. These are rather cheerless looking sections, with a teaming population, small and low houses, unpaved streets, and rather poor utilities and other public services. Some of these sections have begun to change into urban nuclei. They differ from each other by a number of functional shadings: Bangu is a textile industry center; Deodoro, Marechal Hermes, are developments for military personnel; Madureira (380,000 inhabitants) is an agricultural trading center; Campo Grande (80,000 inhabitants) is still partly rural and it is also the home for numerous workers who work in Rio de Janeiro.

4. The metropolitan area. Here we must distinguish the urban region and the metropolitan region (Pinchas Geiger (Pedro), "Essay on the Urban Structure of Rio de Janeiro," Rev Bras de Geogr (Brazilian Geography Review), Vol XXII, No 1, Jan-Mar 1960; Pinchas Geiger (Pedro) and Davidovitch (Fany), "Aspects of the Brazilian City," Rev Bras de Geog, Vol XXIII, No 2, April-June, 1961). The former includes the territory which provides Rio de Janeiro with food, raw materials, population currents and which receives manufactured or re-distributed products; this involves the state of Guanabara, the state of Rio, almost all of the state of Espirito Santo, and a part of Minas. The area includes the zones situated around the metropolis; the development of the area has been planned along large-scale lines. The centrifugal movement led to the incorporation of other localities which existed here earlier; some of them simply became suburbs, such as Cascadura or Jacarepagua; others, such as Caxias, Nilopolis, Nova Iguacu, today, are so-called "dormitory suburbs" [bedroom suburbs] and satellite cities.

A good example of a satellite city, with a certain personality of its own, is Nova Iguacu (Segadas Soares, M.F. de, "Nova Iguacu, Absorption of an Urban Cell by Greater Rio de Janeiro," Rev Bras de Geog, Vol XXIV, No 2, April-June 1962); it is located in the state of Rio, 35 km from the center of Rio de Janeiro, along the border with the state of Guanabara. A railroad line built here in 1858 turned the Marambomba [sugar mill] into a settlement. During the tremendous development of citrus fruit cultivation, it made tremendous progress and then became a processing and shipment

center for oranges. World War II cut off the export business here and this created a crisis. In 1945, thousands of crates of oranges were simply buried and many orange trees were cut down and turned into lumber. But the city bounced back and became an industrial center and a "bedroom" suburb; it remained a center of supply and services for a vast region. The heavy volume of movement on roads and highways, the farmers and their wagons, of course are the characteristic features of the function of this city; but, in the vicinity of the stations, in the morning and at night, when the commuters leave or come back, we can observe the other aspect of this area; here we have an average of 549,000 commuter trips, of which the railroads handle 56%; out of 13,818 industrial workers registered in the recent census, only 3,216 were employed in the township as such. We cannot say that Nova Iguacu does not have any industry at all; but, except for "A Usina Mecanica Carioca," machine-building plant, which employs 312 workers, and a plastics factory, employing 267, the others constitute small establishments; the majority of them employs less than 5 persons. On the other hand, however, it did assume considerable importance as a regional center with good commercial development and it has a potential for further growth because it offers the population of this vast area a number of services, such as public health, education and banks. In fact, this is not just a suburb; instead, it is a real satellite city.

The advance of urban development does not prevent the existence of an agricultural sector which is quite active and which can be found in the more out of the way portions of the urban center. One of these regions, called Mendanha, has been subject to a special study (Da Silva, Hilda, "An Agricultural Zone in the Federal District -- Medanha," Rev Bras de Geogr, Vol XX, No 4, Oct-Dec 1958). There are crops in the valley of the Guandu do Sena River or the Prata do Mendanha River and their tributaries, along the Guandu do Sape River, along the two Caboclos rivers -- approximately 4 km wide -- where we come to the lowlands of the Mendanha between the Mendanha mountain range, the southern part of the Madureira mountain range and the Quitungo mountain range, a spur of the Pedra Branca massif. Contrasting quite neatly with the nearby surburban regions -- Campo Grande and Bangu -- the Mendanha section remains an agricultural region, in spite of the threat from real estate parcelization and the vacation homes which are beginning to spring up along the big highway from Mendanha. There is just about no industry here as yet, with the exception of the manufacture of various equipment items and fittings at Marinha, in the Guandu do Sape section. The black soil, resulting from the decomposition of the crystalline rocks, as well as the tropical climate keep the region an agricultural one. However, this is a rather subordinate form of agriculture, strictly speaking, since it is very closely tied in with the market; these are connected to Mendanha by some rather good roads. Wherever we look, we can see small farms properties with mixed crops: cassava, garden eggplants; chicken farms, orange groves along the residual [remaining] hillocks, stretching along the bottom of the valley. These orange groves managed to survive the great crisis but they are confined to the type of product that is not very desirable for the export market.

The mountain ranges were not abandoned [sic] (Bernardes, Nilo, "Notes on the Human Occupation of the Mountains in the Federal District," Rev Bras de Geog, XXI, No 3, July-Sept 1959); but we do note the contrast provided by the slopes which are peculiar to these mountains. In this relatively dry and sun-drenched area, we find fields, orange groves, cassava plantations, along with banana groves and chuchu. In addition to the basic plants, the people here also plant various root crops such as potatoes, turnips, carrots, and, for their own consumption, black-eyed peas and millet, with the latter being used also for the feeding of birds [poultry] and hogs, although on a small scale. The people here use every possible piece of land for their crops, including the less steep slopes, the small hanging valleys and, very often, the very small little corners and angles between the mountain blocks. It is really odd to observe that the inhabitants of these mountains here do not seem to know anything about soil erosion; the orange trees, for example, are planted in long rows, following along the lines of major slopes, leaving vast bare spaces in between. The Portuguese immigrants from the islands tried a number of modest earth works here, including ditches and stone walls. In contrast to the Portuguese from the continent, who settled in the lowlands, the island Portuguese, coming from mountainous country, went straight for the hill country; they are particularly numerous in the massif of Pedra Branca. This mountain-type agriculture is also tied in with the urban markets; but it is rather difficult to transport the products all the way to the market or at least to the highway that leads to the market. Transportation, from the mountains, involves a rather steep network of trails which can barely be negotiated by burros and mules. This mountain agriculture is rather poor and this of course is reflected in the housing and living conditions; very few are made of stone, thus indicating a higher standard of living.

Today, as in many other countries, the city extended its tentacles longer and longer; the real estate plots, which took over the entire suburban zone altogether, now threatened to submerg the urban area; in Medanha and, generally, at the foot of the mountains, we can observe many uncultivated plots of land; the owner of this land simply sits around and waits for the time when he can sell it at a profit. But perhaps this type of evolution might be beneficial after all and some writers have noted that the big city might lose a source of fresh food products which contribute to the well-being of the people.

[No 184, pp 112-117]

Cartographic Situation of the Northeast (Synopsis) presented by Geographic Engineer, Major Criseu M. Chaves

The cartographic situation of the area in which SUDENE (Superintendency for the Development of the Northeast) is operating in the Brazilian Northeast is obviously determined by three major limiting factors: its

vast geographic extent estimated at about 1,600,000 sq km; the technical resources and production capacity of the official surveying agencies and some private companies; and finally the weather conditions of this region which are not always good for taking aerial photographs. The combination of these factors, as of now, presents us with a map making panorama which is not one of the most encouraging; this is why SUDENE worked out a general map making plan for the 3-year period from 1963 until 1965, the first phase of this effort; this general plan consists of uniform aerial photography coverage, using the super-wide-angle lens camera and small-scale mapping to permit general studies and regional planning.

A brief look at the picture represented by the aerial photogrammetry coverage of the Northeast shows us a wide variety of flight mission scales and empty spaces amounting to almost 40% of the operational area of SUDENE. In addition, it so happens that almost all of the flights were conducted prior to the establishment of SUDENE, for specific and not systematic purposes, such as we would have to have them for the planning of vast regions.

We see that 125,000 sq m [sic] of the area of the Northeast has been covered on a scale of 1: 40,000; 840,000 sq km were covered on a scale of 1:20,000 and about 5,000 sq km were covered at various other scales, between 1:4,000 and 1:10,000.

The aerial photography coverage which we mentioned earlier was carried out by the following aerial surveying agencies of Brazil: the Directorate of the Geographic Service of the Army, the Brazilian Air Force, and a number of private companies, such as the Cruzeiros do Sul Aerial Photogrammetry Service, Pospec, Geofoto, Lasa, etc.

The cargographic map of the SUDENE which, in its first phase, is to be prepared during the 3-year period from 1963 until 1965, calls for an aerial photography coverage on a scale of 1:70,000 of about 70% of the area covered by the states of the Northeast in which SUDENE is operating.

It includes about 372 grid squares with a size of 30' x 30' and it covers practically all of the townships of the states of Maranhao, Piaui, Ceara, Rio Grande do Norte, Paraiba, Pernambuco, Alagoas, plus a small part of Sergipe and the northern part of the state of Bahia.

The geographic maps and the topographic maps available on the Northeast come to us from government sources responsible for the systematic mapping of the country or from specific projects carried out by agencies such as the DNOCS (National Department of Drought Control Projects), the DNPM (National Department of Mineral Production), Petrobras, the DNER (National Department of Highways), the CVSF (Sao Francisco Valley Commission), etc.

As regards the government aerial mapping agencies, we can say that the CNG (National Geographic Council) has already completely mapped the area

in which SUDENE is operating on a scale of 1:1,000,000, on sheets of 6.° x 4.°; about 85% of this same area has been covered on a scale of 1:500,000 in sheets of 3.° 00' x 2.° 00'; and about 35% were covered on a scale of 1:250,000, in sheets of 1.° 30' x 1.°. The CNG is today properly equipped for preparing topographic maps on a scale of 1:100,000, using the modern WILD equipment for aerial photogrammetry restoration, on the basis of aerial photographs taken with the super-wide-angle lens.

Recently, the CNG, for the purpose of stepping up national cartography programs, signed an agreement with the AID (Agency for International Development), an agency of the government of the United States of America, represented by the USAID/BRAZIL; this was done in order to give the country an adequate topographic foundation for studies on natural resources and for the planning of the other sectors of Brazilian economy.

The DSGE (Directorate of the Geographic Service of the Army), whose mission consists in preparing maps involving the planning and execution of military operations, is particularly concentrating on topographic maps on a scale of 1:50,000 and 1:25,000; the first of these, is the regular map put out by the DSGE. In 1958, the special surveying commission for the Northeast was created with headquarters at Olinda; it was assigned the mission of continuing the work launched during the last war by the former special detachment of the Northeast.

The DHN (Directorate of Hydrography and Navigation), an agency of the Ministry of the Navy, in addition to other activities directly connected with navigation problems, is also publishing hydrological maps for the entire Brazilian shoreline and some of the most important rivers. Its basic plan for nautical cartography of the coast of Brazil consists of 22 maps on the Mercator projection, on an approximate scale of 1:300,000.

Other government agencies, such as the Directorate of Airlines, the Weather Service, etc, are working on the national cartographic problem within their specific missions.

The cartographic effort applied to the specific projects of the federal and state government agencies dealing with hydrological, geological, petrological and other studies would appear to be confined to rather restricted areas where we work with small, medium, or large scales, depending upon the particular objective.

We must point out, with respect to the Brazilian Northeast, the mapping of the basin of Sao Francisco River on a scale of 1:25,000 in sheets of 7.5' x 7.5', covering an area of approximately 90,000 km^2 based on aerial photographs covering about 600,000 sq km of this very important region.

Since it is the highest Brazilian government agency charged with the responsibility of promoting the development of the vast Northeast Region, the

SUDENE is quite aware of the national cartographic problem and is trying to fit its studies and plans into the modern processes of aerial surveying; it is making maximum use of the resources it has available, resources which only aerial photographs can properly bring out.

Among the most important projects currently under way at the Cartography Division of SUDENE we have the aerial photogrammetry restoration of about 1,000 sq km of the middle portion of the Sao Francisco, the photographic coverage of the basin of the Jaguaribe River, with about 80,000 km^3, and the aerial photogrammetry restoration of the basin of the Salgado River, in the state of Ceara. The first of these projects is intended to constitute the basis for studies for irrigation whereas the activities in the basin of the Jaguaribe are part of the general program which the SUDENE has worked out for over-all studies of the principal basins of the Northeast.

Comments on the Vegetation Studies Made by LASA

Presented by Dr Luiz Mariano Paes de Carvalho

Activities in this sector have been carried out in a continuous fashion on a scale of 1:25,000, for the following purposes:

(a) Selection of areas for national parks; this involved the following surveys: general phytogeography; current conditions; hydrography; communications system; indication of areas and places that would be interesting from the tourist viewpoint; boundaries of these parks, which should of course be natural boundaries, as well as other data;

(b) indication of areas to be used for forest reserves; since a national park does not exist for any human interference in nature as such, except of course to make the use of the park more efficient, we find that a national forest or forest reserve has a definitely economic significance; as the result of the devastation of our forest resources, which we can witness today, we must establish protective areas where conservation methods can be employed;

(c) Preparation of basic maps for forestry inventories; the shortage and lack of precision of the elements indispensable for this effort, in maps currently available, do not enable us to outline the forest inventory of vast areas; this can be done only after plano-altimetric (or at least planimetric) survey, where, in addition to the representation of common elements, we also can see the vegetation, especially as regards the forestry formations;

(d) Land use maps; specifically with respect to the dam at Furnas, we have, in addition to the usual planimetric elements, a representation of permanent and temporary farm land; various types of pastures; forests; types of soils and soil characteristics.

On this scale it is very difficult to identify the species cultivated, unless they reveal definite characteristic differences, such as coffee crops,

sugar cane plantations, etc.

(e) Geo-economic surveys; in this type of service, in which all of our sectors operate together, our particular service concentrates on the problems of vegetation in their various aspects.

Among these other sectors we have: pedology, geology, hydrology and highways; these likewise continuously use the same scale. The geologists prefer a scale of 1:40,000. But even in our sector, the scale of 1:25,000 serves at certain levels, of course not on all levels. For the study of the vegetation formations, it does the job. For more detailed studies, we need larger scales, such as 1:10,000 or 1:15,000.

If forest surveys have already been conducted, using photographs on a scale of 1:25,000, this is due to the fact that, for these areas, we already had photographing missions flown on that scale; this, especially, involves the pine tree section; this species of tree can be distinguished perfectly clearly on that scale. For the determination of other species, this scale creates great difficulties -- unless they reveal very obvious characteristic differences, such as in the case of the pine trees. A lot of training and practice, involving not only the continuous processing of photographs on that scale, but also a more thorough knowledge of the subject matter analyzed in this fashion, it might be possible to determine more elements than those that have been spotted so far.

D. Heinsdijk informed me earlier that he had worked with photographs on a scale of 1:40,000, in Amazonia and that he was even able to recognize some species.

For the purpose of land-use surveys, we believe that 1:10,000 is the minimum preferable scale.

These indications however should be taken with a grain of salt because we must consider not only the possibility that we already might have a survey on a particular area, but also that there might be some recent photographic coverage; in this case, there of course is no alternative for the choice of the scale and this does not happen infrequently, either.

We must also consider the economic importance of the areas to be studied, in view of the cost of these missions, the immediate objectives, and even the degree of precision and detail required. A country of continental dimensions covers a vast area which might not yet require any detailed studies, at this stage of the game.

The above considerations, in my opinion, appear to be valid in view of the execution of these projects and the requirements arising from this.

For the purpose of information and education, we must consider other aspects: the inexperience of the student, the need for long training until he develops the right kind of stereo-vision -- something which produces less

flexible requirements with respect to scale indication.

Speaking quite frankly on the training of photo-interpreters at the various schools, it seems to me that the problem must be tackled from a more realistic viewpoint. We are of course all agreed on the growing need for training a large number of technicians who will be able to handle a wide variety of fields, who will be able to pick up where we left off and carry this effort on and make improvements; but we must not forget that there are certain fields of specialization which are just as necessary as photo-interpretation and photogrammetry and which are now being prepared; in other words, we have people being trained in these fields now but their horizons will for some time remain rather restricted to a particular function.

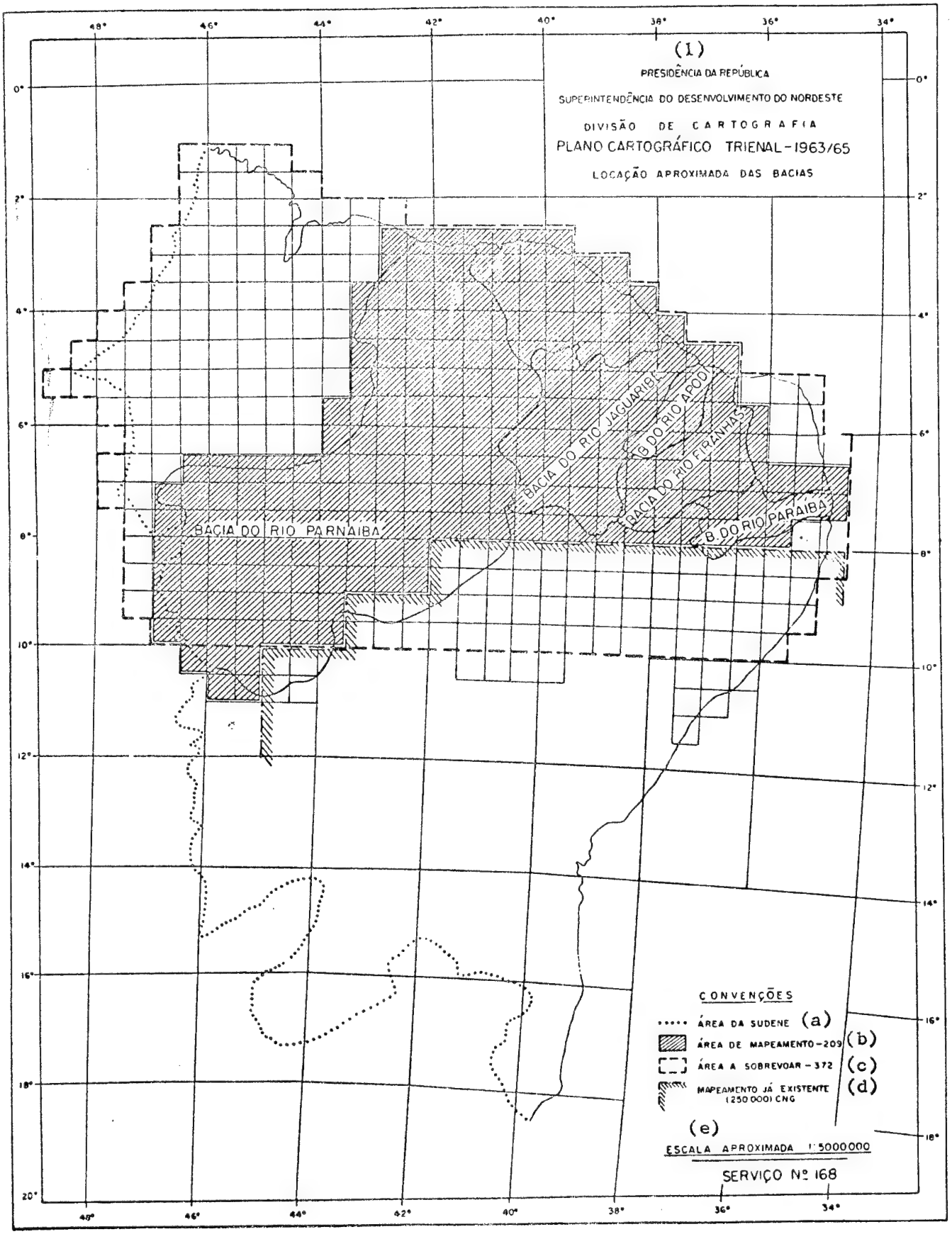
It seems to me, looking at it right now, that it would be a bit daring to go into a systematic promotion of the training of researchers in photo-interpretation and even professional experts -- because how can you guarantee that these highly skilled technicians will really be used to the fullest extent?

Would it not be wiser if our higher-level schools were to teach these specialized subjects? In other words, these students would then have at least a basic knowledge and they could then be farmed out to the various professional and research sectors already in existence and there they could get some more on-the-job training. This would give us greater penetration and coverage, especially in those areas which we must have a much better knowledge of and where the various disciplines will have to work together. At the same time, some people who are currently more interested in these fields of specialization could then also be used in those areas which at this time are rather restricted and which might also be paralleled by a similar effort among our public and private enterprises.

Finally, as a result of the development process mentioned earlier, there will be more and more possibilities coming up and the field of activity for a larger number of highly specialized technicians will keep growing.

As far as the problem of photo-interpretation as a field is concerned, I believe that the photo-interpreter must have sufficient basic knowledge of the subject he is going to work on and its local characteristics. Let me give an example: how difficult would it be for a man to try to do a photo-interpretation job on vegetation if he does not have even a basic knowledge of the elements of ecology, phytogeography, botany, and so on, just to mention the most important auxiliary sciences involved here?

FIGURE APPENDIX



Legend of map on preceding page:

(1) Office of the President of the Republic, Superintendency of the Northeast, Division of Cartography, 3-year cartography plan, 1963-1965, approximate location of basins; symbols: a - SUDENE area; b - mapping area, 209; c - area reserved for overflights, 372: d - existing mapping coverage (250,000), CNG; e - approximate scale.

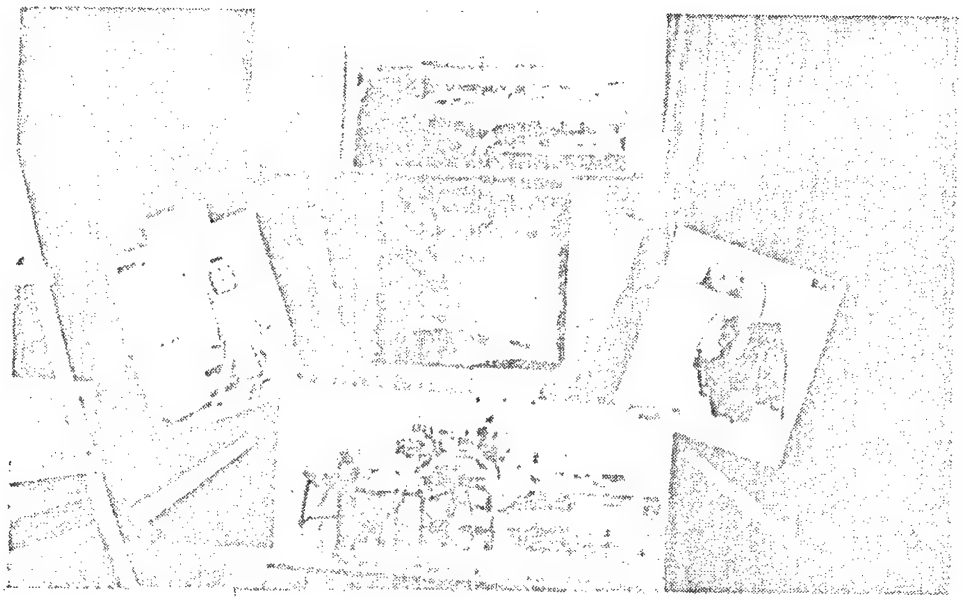


Figure 5. Stand showing instruments and aerial photographs taken by the Wild Company.

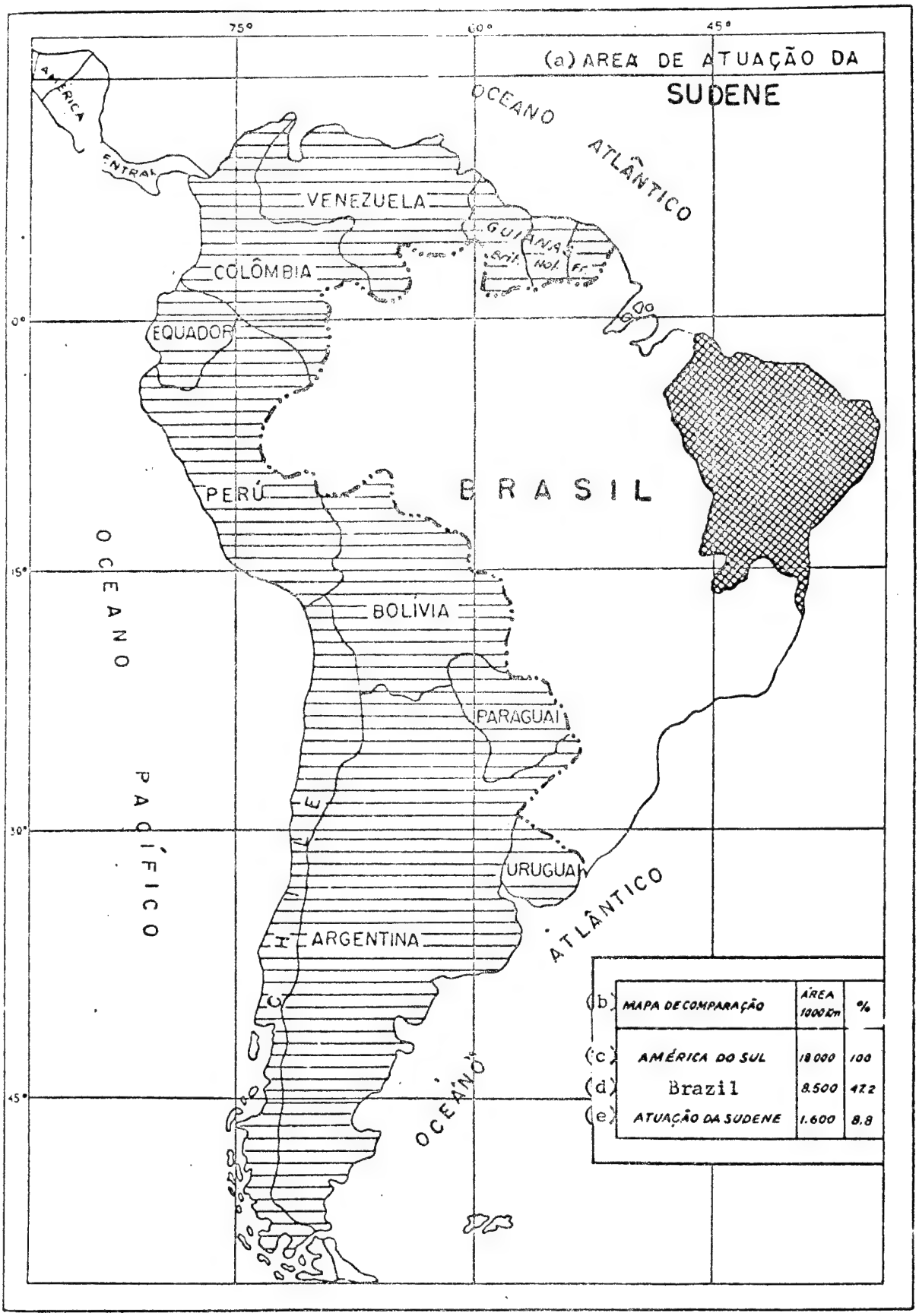


Figure 6. a -- area of SUDENE activity; b -- comparison map; c -- South America; d -- Brazil; e -- area of SUDENE activity.

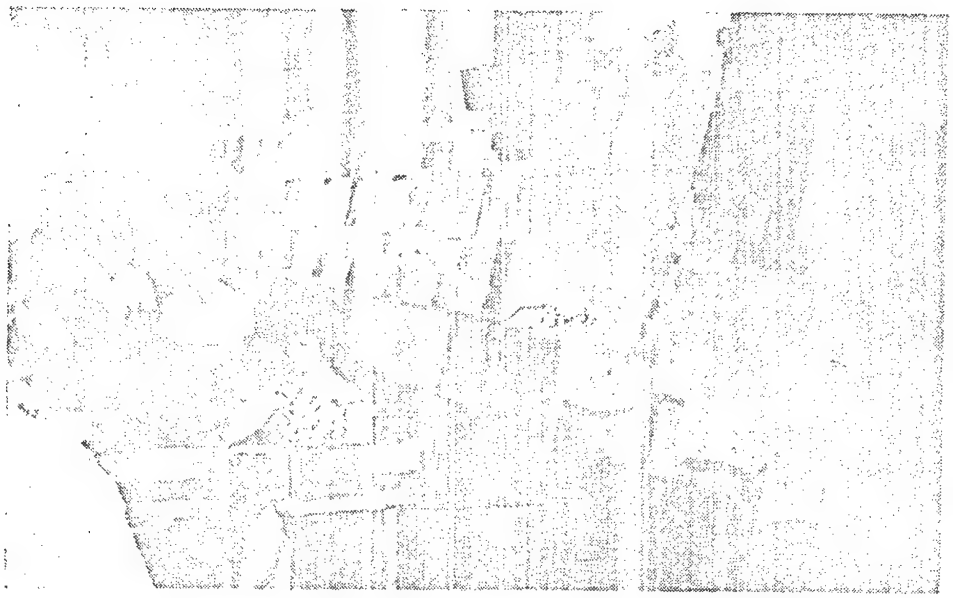


Figure 7. Partial view of stands.

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The Major Climate Regions of Brazil

I. Comments on Vegetation Types in the Southern Region

Henrique P. Veloso

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The region which we propose to study here today and which contains a wide variety of ecological conditions ranging over the whole gamut of vegetation types of the country, includes the drainage basins of the Parana and the Uruguai, the southern part of the sedimentary highlands and the escarps of the Mar and Geral mountain ranges. This region was described by Saint-Hilaire (53), Martius (36), Lindman (33), etc; at the end of the last century, this area was carefully analyzed in the studies of Warming (66) and the observations of Ihering (28). The basis of geological studies, Pauwels (41b) and Maack (35c), tried to explain the current vegetation formations; on the basis of physiological research, Rawitscher (48b and 48c, and associates (20 and 44)), clarified a number of questions dealing with the vegetation; Beard (7), Viana (65), Setzer (57a), Alvim (4b), and Pavageau (42) analyzed the land of the prairie sections here in various places and managed to tie this part in with the soil structure and composition; finally, Valverde (62), in a magnificent geographic synthesis of the souther highlands, prepared and discussed and tried to clarify a number of the problems arising here.

I would like to point out that this work does not represent a repetition of this information; it is the result of countless observations in the course of my detailed studies (63 and 64).

Brazilian Phytogeography (Synthesis)

Before going into an explanation of this topic, we must have a general knowledge of the Brazilian vegetation cover (14 and 66b).

Looking at it generally, the vegetation here is quite obviously a result of the weather conditions which were, in turn, influenced by the relief and by the soil conditions. This being the case, Brazil reveals the picture of a quite diversified vegetation area as far as the floristic aspect is concerned (17c, 17d, and 31a). (We can quickly summarize the landscape here as follows (the so-called "large swamp complexes," which the majority of biogeographers consider as constituting a floristic zone, in my opinion is nothing more than a miniature version of what is happening in the case of Brazilian vegetation altogether; here, as in the rest of the country, we have samples, so to speak, of forests, prairies, and open fields,

all of them within relatively small areas which, probably, correspond to the floristic sections in this region; however, we do not have any major, well-balanced areas here. Thus, in the area of the arenitic and calcareous outliers, situated away from the direct influence of the rivers, we find prairies; the low marshlands, where drainage is rather difficult, we find forest groups which sometimes reveal deciduous trees, predominantly (Tabebuia, Bignoniaceae), and at other times various species of evergreens or, now and then, palm trees (Copernicia, Palmae), constituting specimens of the palm-leaf forest; along the rivers, forming fringe strips of varying width, we have ciliary forests with mostly Leguminosae; finally, along the meadows and low grassland sections bordering on the streams, and in vast sections of the periodically floods plains, we find grassy fields of Paratheria predominating in the major portion of the region.)

1. Forests ..... (broad-leaf.....(equatorial
   (pinna-leaf (tropical
   (palm-leaf

2. Prairies..... (scrub woodland
   (woods composed of stunted, twisted trees, growing on cattle-grazing land

3. Fields

4. Wooded sand bar.. (beaches
   or spits (dunes

1. Forests: This is a type of vegetation marked by a dense tree population and its most important characteristic is represented by the huge trees, intermingled with clusters of smaller trees.

Today the Brazilian forests contrast with the other existing types of flora not only because of the diversification of the relief (1d), but also because of the tremendous amount of human activity here. We thus have three types of forests in Brazil, looking at it from the differences in the appearance of the landscape: broad-leaf (thick [jungle-type] forest), pinna-leaf (pine grove), and palm-leaf (coconut palms).

The first type here, the broad-leaf forest, is divided into the equatorial and tropical forest; in the Amazon region it takes up a large part of the "equatorial forest complex of America." In Brazil it extends toward the east, to the banks of the Grajau River in the state of Maranhao; turning south, it spreads all the way to the northwestern part of Mato Grosso (60). The tropical forest includes primarily the forest along the Atlantic Coast, covering the eastern scarp of the Brazilian plateau and extending from the area of Rio Grande do Norte all the way to Osorio, in the northern part of Rio Grande do Sul; in some points it pushes into the interior, accompanying the valleys of the big rivers (6b). Although these forests reveal a number of differences from the viewpoint of the flora, due to the area covered in terms of latitutde and due to the considerable variation in the relief, they do offer us a rather uniform landscape aspect when it comes to their vegetation as such which of course is tied in with the high degree of humidity (55a). The other section here, called the forest of the drainage

basins of the Parana and Uruguai, includes all of the dense forests in the interior of the country which cover the valleys of these rivers. It extends along the tributaries on the left bank, from the Tiete all the way to the Iguacu and continuing along the valley of the Uruguai, up to its tributary, the Ijui; it then widens, to the north of the Tiete, in the form of broken-up forest groups until it reaches the Rio Grande. It actually covers two different areas: one has a rather gentle relief, to the north of the Tiete, with discontinuous dense forests intermingled with prairies; the rainfall here is more or less subdivided into two seasons; the other area, running to the south of that river, features continuous dense forests in valleys with a rather sharply cut relief; here the rather moist climate is a reflection of the rather uniform rainfall situation (35c and 62). In this type of forest we include the swamp formations where the "manguezal," with a dense vegetation occupying the salty areas along the coast, is the only feature that stands out from the landscape. It peters out more and more and becomes lower as we go further south and it then is found in broken up groups from the Amazonas all the way to Santa Catarina (38 and 58).

The second type, the pinna-leaf forest, covers the southern plateau where we find its main area of distribution. As we approach the equator, it becomes increasingly rare and then exists only in a few higher elevations (25a).

The third type of forest, the palm-leaf forest, is interspersed among the equatorial forest and the prairie; it covers the northwestern section in rather dense groupings. It pushes into the interior in isolated groups and here we find it along the Tocantins and the Araguari rivers, in Goias; we also find it along the Sao Lourenco and Alto Araguaia rivers and south of the "large marshland and swamp region," in Mato Grosso; in Minas Gerais, in the mining industry triangle (55a), we can also find some of it. Nevertheless, it predominates among the scrub woodland of Ceara-Piaui and the forest of Maranhao-Para; from here it continues until we reach the territory of Rondonia in a rather narrow and discontinuous strip, between the Amazonia forest and the very thick forest area in Mato Grosso and Goias.

2. Prairies: This is a type of vegetation characterized by small, rather widely spaced trees; the soil here is covered by grass which, in the more humid areas, forms a continuous vegetation carpet (66a).

The term "phytogeography" of the prairie includes two quite different vegetation formations: the scrub woodland and the woodland savanna vegetation (15).

The former, the scrub woodland, is a characteristic formation of the Brazilian northeast and covers the northerastern block of the sedimentary plateau, advancing up to the Gurgueia River in Piaui and, in isolated groups, all the way to the Maranhao. Turning south, it predominates in the interior of Bahia, and widens until it reaches the northern part of Minas Gerais; from here, in isolated groups, intermingled with other types of vegetation, it extends along the valley of Jequitinhonha, the Contas River, etc (55a); in rare cases it may be spotted in the vicinity of Miranda in the state of

Mato Grosso. The vegetation of the interior of the northeast exists in a semi-arrid climate, where the primary feature is the rather accentuated dry season (18); of course, this type of vegetation is not found here exclusively. The deciduous vegetation formation rapidly flourishes and blooms during the rainy season; but during the dry season it takes on a rather desolate appearance and the almost absolute lack of leaves makes the whole area look hostile and almost aggressive (4a and 34).

A second, thick forest, is a characteristic formation of the Brazilian central west; it is rather widespread here (15). It extends in a continuous formation, from Belo Horizonte (MG) through the states of Goias and Mato Grosso until it runs into the Amazonian equatorial forest (31d). Isolated groups, sometimes quite large, extend toward the north, in the middle of the equatorial region, in the territories of Roraima and Amapa, as well as to the west, forming narrow strips of forest, in the states of Para, Amazonas, and the territory of Rondonia; finally, to the south, the forest here occupies smaller areas, in localities in the interior of the state of Sao Paulo and Parana. In the center-west, where we have a semi-humid tropical climate (and where the dry season, running into the winter, follows another, not quite as humid summer season), the majority of the tree species have a hydrophile reaction (20); these are plants with very deep roots and enormous leaves (44); this demonstrates the decisive influence of the underground water table on the structure of this type of vegetation (48g).

3. Fields: This is a low-level type of vegetation predominantly featuring Gramineae; it can be found in the southern half of Rio Grande do Sul, in a plain called the Gaucho country"; here it covers the largest section in Brazil (33 and 46a). In the southern plateau, in gently rolling hill country, the fields cover areas called "general fields" in the states of Sao Paulo (Capao Bonito, etc), Parana (Curitiba, Ponta Grossa, Guarapuava and Palmas), Santa Catarina (Lajes and Sao Joaquim), and Rio Grande do Sul (Vacaria, a prolongation of the Lajes fields). In addition, these fields can also be found between the prairie of Campo Grande and the forest of Dourados, in the southern part of Mato Grosso, this being the so-called "Maracaju field area" (55a). These are perhaps the only areas that are still covered with the original vegetation cover; although rather restricted with respect to the other types of vegetation areas, they are being expanded by clearing operations and fire. Thus man can easily transform the forests and even the prairies into secondary fields, using fire to the detriment of the forests and the prairies (31b).

4. Wooded sand bars: This type of vegetation can be found along the narrow maritime strip where it is the only major feature; it includes two different formations: the beaches and the dunes (48d).

The former, a formation made up of beaches bordered by the ocean, reveals a rather low, creeping vegetation which gets thicker towards the dunes. It extends from the north to the south of the country (17b and 33).

The second one, here, the dune formation, predominantly revealing

a wooden vegetation of rather small importance, nevertheless is quite uniform, and this, plus the density of the component features, constitutes its main characteristic. This strip is very narrow along the coastline in the north and northeast but it becomes much wider in the southern region (17b and 33).

General Comments

Now that we have covered a rather quick review of the landscape types here, we can go into our more detailed study of the souther region of Brazil; here we have four major types of vegetation, that is to say, the forest, the prairies, the fields, and the sand bars.

The vegetation types, generally speaking, should be course correspond to the weather, as described by Schimper (56) and, more recently, by Rubel (51). But a general description is not enough if we want to get an accurate picture of this cause-effect relationship; this is why modern phytoclimatology tries to come up with a classification of the influence of the weather factors that might limit the distribution of various vegetation forms (5). After Humboldt (26), who was the first to sketch the over-all outlines for a phytoclimatic classification, there were others, ending up with Koeppen (30) who used the relationship between rainfall and maximum water vapor pressure during the months with the heaviest rainfall. He was then followed by others who had the same objective in mind, such as Mayr in 1925, Salianinov in 1930, Trumble in 1939, and Emberger in 1942 (in Philipps, 1953 (43)). All of these authors, however, did not come up with a satisfactory solution of the problem of the vegetation coverage as an expression of the climate at a particular moment. Then Thornthwaite (61) tried to clarify the reasons for the presence of the vegetation coverage, with its rational climatic limitations, starting with a comparison between the potential evaporation and transpiration and the rainfall, that is to say, the quantity of water which is returned to the atmosphere through evaporation and transpiration, under optimum soil moisture and vegetation cover conditions. This therefore creates the need for a delimitation of these factors so that we may have an idea of the environment [regime] required by each type of vegetation and so that we may thus correctly tie in the climate with the actual vegetation cover distribution (13).

On the basis of weather station reports, Setzer, working in Sao Paulo (57d), Maack working in Parana (35c) and Rambo in Rio Grande do Sul (46a), concluded that the actual climate of the region is a forest climate and that the other vegetation types encountered here are, according to the last two writers, the leftovers and, according to the first-named writer, the product of devastation and fire. The climate is a result of a combination of physical factors, deriving from the meteorological elements and from geographic factors; it gives the vegetation an individual characteristic depending upon the distribution of the quantity and humidity which is brought in through air circulation in connection with the relief (21). We therefore believe that a knowledge of the climate must be combined with geomorphological information in order to give us further clarification on the flora (1, 2, 11, 35, 37, 41 and 52c).

It is very difficult or almost impossible -- with the knowledge we have about Brazil today -- to determine the beginning [climax] of each formation or of the same type of vegetation. One thing we, however, can accept, is the fact that, during the Quaternary there was an epoch characterized by local weather fluctuations, which was expressed in our current vegetation picture (37b). Thus Maak (35c) and Ab-Saber (1b) think that there was an expansion of the Atlantic forest at the end of the Pleistocene or, at the very latest, in the beginning of the Holocene.

A portion of the plain, with its tremendous post-Pliocenic sedimentary deposits (1c and 41a) and its recent marine deposits (32), evidently signified a much more modern expansion of the tree flora. The same thing, probably, happened with the broad-leaf forest in the drainage basins of the Parana and the Uruguai, where the entire recently rejuvenated terrain continues to be occupied by an expanding forest.

In the northern part of the sedimentary plateau of Parana, the existence of laterite under the forest, which Maak (35c) used as an argument to set up the assumption that there was a recent forest expansion on top of the prairie areas, could barely prove, that, as far as the current area with uniform rainfall distribution is concerned, there was a semi-humid period during epochs not too distant in the past; Guerra (22b) observed similar facts in the forest of the territories of Amapa and Rondonia; he thinks that the formation of laterite under the forest cover is quite possible. This still leaves us with the problem of forest expansion as part of our local study program.

We know that the post-Cretaceous movements completely transformed the plateau; they broke it up and they raised the Paleozoic sediments which were slowly eroded (1a). Now, the conifers, whose known climax occurred during the Triassic-Jurassic (19), probably suffered almost complete extinction as a result of these movements and the subsequent erosion processes. They must therefore be considered as being restricted to the crystalline plateau and, perhaps, to a few isolated points in the sedimentary plateau; more recently, they expanded through the tremendous drainage network, where the elevation compensates for the latitude. This, perhaps, explains the current rather discontinuous distribution in the Mantiqueira and Mar mountain ranges. We also know, that during the Quaternary, when there was a considerable increase in the rainfall rate, the valleys were widened even more, thus facilitating the expansion of the broad-leaf forests which were occupying smaller areas, with a probable increase in the humidity and heat (due to the lowering of the base level)(37). As a result of these geological processes, the Brazilian pine forest expanded throughout the plateau where its heavy seeds, transported by the water, sprouted along the valleys that were not yet quite deep at that time. Even today we can find vast nuclei situated in the level hillsides and the high slopes of the valleys whose valley bottoms are covered with dense broad-leaf forests. Thus, the expansion of the forests, dominated by heliophile species, became possible only in areas where the vegetation cover was the creeping type of vegetation.

On the basis of the concept of the pre-existence of swampy and desert areas (12), we worked out a scheme for the principal Brazilian vegetation families, based on Wettstein (68), Emberger (19), and Hutchinson (27).

In the diagram (Figure 2) we can see that certain types of flora, outlined by the biological forms (47), always correspond to certain evolutive groups. Thus, in the forest type, we find, predominating along the shaded and very moist slopes, the ciophilic phanerophytes with the heavy seeds; these are rather primitive and also constitute the sub-forest of the other communities [underbrush] whose general characteristics are similar to the previously mentioned ones -- Polycarpicae (Magnoliaceae, Lauraceae, Annonaceae, Myristicaceae and Monimiaceae); in the forest in the Amazon basin, in most of the ciliary underbrush and in the forests of the drainage basins of the country, we can find heliophile phanerophytes with light seeds that are easily transported and that belong to the most highly developed groups -- Rosales (Leguminosae, etc); and, finally, as companions of these families, we can find even more developed groups, the Myrtales, Meliales and Apocynales. The other types of forest, "coconut palm forests (54)" in the northwest, the "pine tree forests" in the southern plateau, and the "manguezais" [mangrove forests] along the Atlantic Coast are dominated by heliophile phanerophytes with rather heavy seeds; the first two communities are made up of primitive groups -- Palmales (Palmae) and Coniferales (Araucariaceae) -- and the last, consisting of a considerably more developed group which is represented by the Myrtales (Rhizophoraceae). In the prairie type, we encounter, in biological sub-forms (44), the heliophile phanerophytes with the light seeds -- Guttiferales (Dilleniaceae) -- or with the heavy seeds -- Theales (Caryocaraceae) and also the feathered and easily transported seeds, such as the Tiliales (Bombacaceae), Guttiferales (Guttiferae) and Polygalales (Vochysiaceae); the second group is more primitive than the others and the Polygalales tree group is the most highly developed. In addition to these families, making up the highest portions of the prairies (scrub woodland), we can find some succulent camephytes, relatively primitive Cactales (Cactaceae) and Triccocae (Euphorbiaceae), with rather meaty and heavy fruits; on the other hand, the vegetation carpet here is made up of hemicryptophytes (Gumiflorae), camephytes (Cyperales) and geophytes (Litiflorae, Gynandrae, etc). Finally, in the field-type of vegetation formation, when this formation is found in a xerophile environment, we find predominating the hemicryptophytes and the camephytes whereas, in a hydrophile (swampy) environment the geophytes predominate.

Looking at our map (Figure 1), we can see that the points of dispersion of the present-day Brazilian flora, probably, are found in the "arquean shields" (1d) and this is certainly the reason for the identity we encounter here, especially in view of the ecological similarity (48f).

Broad-Leaf Forests

Next, we can describe the forest communities which occupy the drainage basins of the Parana and the Uruguai and the southern Atlantic Coast; we can also study their ecological aspects.

1. The forest in the drainage basins of the Parana and the Uruguai cover the entire northeastern part of the sedimentary plateau, from the Rio Grande (SS) all the way to the Ijui (RS). It also appears in the alluvial terrain of the major tributaries and along the slopes and valley bottoms of the deepest valleys, dropping to elevations between 300 and 500 m, where the relief becomes quite curved.

The appearance of the forest here is quite imposing (Figure 3), with trees as high as 30-40 m, trees with thick trunks, tremendous branches, forming a low and thick layer quite definitely dominated by Lauraceae and a hydrophile underbursh with evergreen leaves; here the Myrtaceae, Rubiaceae and Piperaceae predominate in an environment of entangling lianas and epiphytes. The upper stratum, in the northern part of the area, is dominated by two types of easily transported seeds and deciduous leaves: Aspidosperma (Apocynaceae) and Cedrela (Meliaceae) (Figure 4). These types, in the vicinity of the Rio Grande, make up the biggest and most humid layers interspersed in the prairie [bush country] environment, with characteristics identical to that of the continuous forest of the region. Along the tributaries on the right bank of the Uruguai River we find predominating the Piptadenia (Leguminosae) genus; these have small seeds, big and relatively light beans. Further to the south, the genus Patagonula (Boraginaceae) gives the area along the tributaries on the left bank of the Uruguai a new appearance. This element makes up the layers to the south of the Ijui, giving the countryside the appearance of a vast expanse of fields interrupted by clusters of low brush forest, where Patagonula americana (guaibira) dominates in a group of ciophilic plants, the Myrtaceae.

2. The forest along the Atlantic side, as we can see, occupies the entire narrow scarp of mountain ranges and the broader portion along the coast, including the salt marsh areas; its southernmost point is at Osorio (RS). The group of scarps, which is less imposing than the preceding one, is dominated by somewhat slimmer and relatively lower trees (rarely taller than 25 m); here the genus Ocotea (Lauraceae) imparts to this formation a homogeneity unequaled by any other Brazilian broad-lef forest (17a, 63a and 64b). This formation predominantly features heavy-seed species and it is accompanied by other Lauraceae, whose genuses Nectandra, Endlicheria and Crytocarya, make up its primary characteristics (63a and 64b).

The portion along the coastal plain is much more complicated and complex than the proceeding one; it is dominated by the genuses Alchornea (Euphorbiaceae) and Tapirira (Anacardiaceae), which are quite widespread here; the species found here can be observed from the Amazonas all the way to Santa Catarina (vicinity of the township of Palhoca); these lower, rather thin and densely growing elements are intermingled with large "fig trees" (Ficus, Moraceae) and this is the principal characteristic in this area. Further to the south, all the way to Osorio (RS) the community is dominated by the genuses Arecastrum (Palmae), Ficus (Moraceae) and Tabebuia (Bignoniaceae) which occupy very moist land, sometimes even swamp land; this is the primary characteristic of this portion (41a, 64c and 64d)(Figure 5).

The forest reveals a common underbrush consisting of Myrtaceae and

Rubiaceae, both in the communities along the coast and in the plain. It also contains a large quantity of pterophytes (whose genuses Alsophila Hemitelia and Cyathea are represented here in major numbers along the scarps of the mountain ranges, mainly along the scarp of the Mar mountain range); here we also find a large number of Bromeliaceae and Orchidaceae which are most abundant in the alluvial portion of the coast. These latter families perhaps represent the element of similarity in these forest communities, both along the slopes and all over the plains where they present us with a picture of a uniform tree landscape full of epiphytes (63g).

The community of marine-influenced alluvium or "mangrove swamps" (24) is dominated by tree species with typical characteristics and imparts to the vegetation picture here the rather very obvious aspect of a densely populated tree formation; here such genuses as Rhizophora (Rhizophoraceae) Avicenia (Verbenaceae) and Laguncularia (Combretaceae) cover the salty (brackish) areas in the bays and in the river mouths (9).

Discussion. The broad-leaf forest communities of the region are more in line with the shape of the relief here (valleys, scarps, and plains) and the quality of the terrain (humid areas, swamp land, marshes) than with the general weather factors, such as the sub-tropical, humid climate with regularly distributed rainfall (8). They also reveal differences in the flora which lead to further considerations (48f). Thus the philogeny of the dominant families (27) and the geology of the region (1a, 1b, 1c, 2a, 2b, 22a, 35b, 41a, 52a and 52b) are quite significant here. The Rhizophoraceae, Verbenaceae and Combretaceae (with species having pereennial leaves), in the salt marsh areas, and the Bignoniaceae (with deciduous species), in the marsh land areas (64d) are quite well-developed families (27); the Sapindaceae and Euphorbiaceae (64c) with evergreen species in the maritime plain (39) and the Apocynaceae, Meliaceae, Leguminosae and Boraginaceae (with deciduous and perennial species), in the drainage basins of the Parana and Uruguai (31c and 45) are less developed than the former (27) and predominate in terrain that is more recent although the environment here is less specialized (rejuvenated and alluvial areas); the Lauraceae and Annonaceae along the Atlantc mountain range scarp (63a and 64b) and the Palmae, Magnoliaceae and Moraceae along the post-Pliocenic side (64d) are the most primitive families which predominate in older terrain sections (colluvial) (1b and 35), Pliocenic and Gondwanic (41a).

The broad-leaf forests obviously are made up of communities of species of these families and many others; here the relief factor decisively influenced their complex constitution. We can observe that the elements of the dominant families have predetermined genetic characteristics -- deciduous or evergreen species, light or heavy seeds, etc. -- thus enabling us to assume different series of occupation which probably correspond to the relatively recent geographic modifications.

The Pinna-Leaf Forest

The pinna-leaf forest, consisting mostly of Araucaria angustifolia (pine tree of Parana), is found in the crystalline southern plateau and pre-

dominates in the Devonian (occupying the slopes above an elevation of 500 m (40 and 49)). It is also found in isolated groups along the mountain ranges, from the Mata da Corda (MG) mountain range, all the way down to the south of Sao Paulo, mainly in Apiai (Figure 6).

In the crystalline plateau, it is associated with Ocotea porosa (imbuya) and Ilex paraguariensis (Paraguay tea), when it is located between the granitic blocks which rise up here, forming the marginal mountain range (primarily in the area of the Negrinho River, (SC). It is gently rolling portion, where find sediments from the Quaternary, in the area of Curitiba, it is associated with Ocotea pulchella (cinnamon tree) and the Myrtaceae of the genuses Myrceugenia and Gomidesia (29).

On the Devonian plateau, the forest almost completely covers the gentle slope and, at the highest points, where the land is gently rolling, we find it in isolated groups, associated with the previously mentioned elements. On the gentle slopes of the spurs, on the alluvial terraces, and along the rivers, it forms larger groups, where we find the first individuals of Dicksonia sellowiana (the Dicksonia fern) and a larger number of Podocarpus lambertii (Figure 7).

In the plateau formed by sandstones with lentils of trapp on the surface, subdivided in blocks by the drainage of the Tibaji, Ivai, Piquiri, Iguacu and Uruguai rivers, it appears in three main forms: layers, in Guarapuava; large groups, in the blocks of the Tibaji; and, finally, intermingled with broad-leaf forest, in the valleys of these blocks. In the eruptive basaltic plateau -- when the formations are arranged transversally from Mafra all the way to Lajes (SC), it exists in continuous groups associated with the species of Ocotea porosa, Ilex paraguariensis, Stoanea lasiocoma and Mimosa scabra (29). When it is located on the high points, such as at Campos Novos, Lajes, Sao Joaquim, etc, we can find it in isolated groups, surrounded by fields; here we can observe a larger number of Dicksonia sellowiana which, in the part surrounded by the valley of the Pelotas River, turns out to be practically the only companion of Araucaria. Finally, when it is located in the deepest valleys, it is generally found associated with Aspidosperma polyneuron, in the valley of the Iguacu; with Piptadenia rigida, in the valley of the Uruguai; and with Chusquea ramosissima (bamboo), Merostachys clausseni (bamboo) and Guadua trinii (large bamboo), these being species which constitute the middle floor or layer of both of them (45) (Figure 8).

Discussion. The historical information of the genus is tied in with the past of the conifers because the Araucaria, in addition to the Brazilian species, also contains a Chilean species and more than seven Australasian species. Something that might perhaps be its oldest form -- fossil remnants of Proaraucaria (near the section of Colymbaea South-Americana) -- was encountered in the Cretaceous of Patagonia (19). We might thus say that the Brazilian species are also connected with the Andean element (46b), where Araucaria imbricata (Valdiviana) is always accompanied by the Podocarpus genus. Its common origin, subdivided into two branches, a South American branch and an Australasian branch, is clear and the Brazilian one probably produced two species, the Valdiviana and the Brasiliana. As for Podocarpus

which is considered as the companion genus of Araucaria (where we have two species of the Valdiviana forest, P. andina and P. nubigenus, and two of the Brasiliana forest, P. lambertii and P. sellowi), we can say that the Brazilian fossil genuses of Cycadites and Elatocladus of the Jurassic of Tierra de Fuego are probably the South American ancestors of this type (19).

Thus we see that the pinna-leaf forest, sometimes the most simple type in Brazil, even though it is dominated by a species with an origin in a rather primitive group, associated with various likewise ancient genuses -- Dicksonia, Podocarpus, Ocotea, etc -- expanded recently (6a), something which has been demonstrated by the geomorphological studies of the region (2a) and which was confirmed by the studies of the growth rings of these trees (23).

Savanna (Woodland)

The savannas are represented in the southern region of Brazil by the "cerrado" [wooded savanna] (25b), revealing their greatest extent along the 24th parallel and, as we can see, are made up of vast stretches surrounded by extensive forests.

In the vicinity of the Grande River, they occur with a certain continuity. But to the south, in Sao Paulo, isolated in the areas of Bauru, Itapeva, and many others, they occupy surfaces of varying size. In Parana, where we have four major groups -- Cinzas River, Araiporanga, Sabaudia and Campo Morao (62) -- the savannas reveal morphological characteristics which are somewhat different from those of the typical woodland savanna; their dominant features here -- Curatella, Qualea, Kielmeyera, and many others of the families of the Leguminosae, Malpighiaceae, Apocynaceae, etc -- are less tortuous and have smaller leaves (50). The terrain, both in Sao Paulo and Parana, but especially in the latter state, is covered by a continuous carpet of grass (48e) (Figure 9).

Discussion. The nuclei of wood savanna located here always seem to reveal certain factors which are common to all of the areas, such as:

(1) laterite -- the old age of the tropcial soils (42);
(2) acid and rather poor soils -- because of their geological origin (4c and 57e);
(3) a rather uniform terrain configuration -- where an often permeable thick layer is superposed on an impermeable subsoil (7);
(4) highly specialized hydrophile species -- which can use the underground water here (44); and
(5) a rather thin tree cover because, in view of the changes in the weather, which ranges from semi-humid to humid (35c), there was no decrease in the natural process of laterization.

Much has been written about this, especially by Rawitscher (48), Setzer (57), and Maack (35); this leads to a large variety of conjectures. The former authors supported the idea of the deterioration of the soil as a result of the forest devastation and the latter author says that this ex-

presses the presence of a wintertime climate which is drier and which, in the past, used to advance further to the south.

Considering the central-west region altogether as being occupied by a vegetation of the woodland savanna type (63c and 67), and assuming that the savanna here represents the most developed form of this category in this environment (16), we must admit that we have a balance between the various sequences here which is identical to the balance of sequences in the forest types, especially since the species always behave in the same manner with respect to the environment they happen to be in (48a). We are convinced of this because of the development of the Dicotyledonea, as well as the other trees, whereas some of the genuses are somewhere within the ciophilic environment of the most humid forests, such as Magnoliaceae (Talauma), Lauraceae (Ocotea), etc; others develop in a heliophile environment which is also humid; here we can mention the following: Annonaceae (Annona and Xylopia), Myristicaceae (Virola), etc; or they might even range from humid all the way to dry, which is true in the case of the savannas where we might mention the following: Dillentaceae (Curatella), Guttiferae (Kielmeyera), Caryocaraceae (Caryocar), etc; the latter are not as old as the former but they are still quite primitive. The same happens in the case of the most recent families, the Leguminosae, Meliaceae, Apocynacae, etc.

Now we can understand the present-day break up of these vegetation types and the various interpretations resulting from this; the erosive force of the excavation was always accompanied by a phase of deposition (12) and this gave rise to the forest dislocations as a result of the aging and constant rejuvenation of the soil. It is obvious that man did contribute to the alteration of the vegetation cover, increasing this rhythm greatly (57c and 57f).

Fields [Grassland or Savanna]

Of all of the areas covered by field vegetation, the one that reveals a prairie characteristic is undoubtedly what is called the "campanha gaucha" (57b). This entire area is covered by strips of forest and interrupted by sections of grassland. In the southern region, as we saw earlier, we find a number of grassland areas, some of them being located in the west and others in the extreme south (55b and 59).

The former occupy the highest points on the plateau, from Sao Paulo all the way to Rio Grande do Sul; thus the so-called "general prairies" cover the part of the crystalline complex: in Curitiba and Castro we find them along with extensive swamp and river plains belonging to the Quaternary (35b); and we find the area also made up of pre-Devonian rocks in the vicinity of Capao Bonito (SP). At Ponta Grossa and in the vicinity, on land dominated by "Furnas" sandstone, we find the most extensive and continuous areas of Gramineae in the Devonian plateau (35a). Finally, on the basaltic plateau of Guarapuava (PR), Lajes and Sao Joaquim (SC) as well as Vacaria (RS), the fields [prairies] dominate in the gently rolling countryside (62). At the beginning of the last century all of these were still dominated by Paratheria, "India love grass" (36 and 53e); today they are covered by clus-

ters and bunches of Aristida (dropseed grass), especially at Ponta Grossa and Castro (35a); this proves that the changes that occurred here were rather recent. Thus the "general prairies," which we find in the southern plateau of the country are characterized by vast grass landscapes, intermingled with layers of Araucaria which are semidevastated (53a), here periodic fires constituted the so-called "fire climax"; this land used to be dominated by Aristida (Gramineae) and Diplothemium (Palmae) (Figure 10).

The second one here occupies the portion of the basaltic plateau which is covered by sediments of the "Bauru" series (3), from the south of Campo Grande all the way to Dourados (MT). We find it covering its greatest extent in the vicinity of Maracaju and Ponta Pora (31d). From here, to the north, in the direction toward the valley of the Terenos River (MT), along the higher slopes (where the sandstone is still quite deep), we find numerous groups of wooded savanna vegetation. To the east, in the direction toward Dourados, along the lower slopes (where the sandstone was more exposed), we can find the first stretches dominated by Aspidosperma (a type of timber tree -- peroba). These prairies, currently made up of clusters of Gramineae (Aristida) are quite far apart, also reflect a "climax of fire."

The third area here occupies the "slopes of Rio Grande," from the Ibicui River (West) all the way to Jacui (East), and up to the border of the Republic of Uruguai (South) and Argentina (Southwest); this is gently rolling terrain, where the grass carpet is rather thin and low on the high, steep-sided tableland whereas it is rather thick on the gentle and broad slopes. Like the "general prairies" on the sedimentary plateau, to the east and west, this area is also covered here and there by forests and isolated clumps of trees. The characteristics of this area, however, vary greatly (33 and 46); here the fire [forest clearing] has rendered the Aristida vegetation quite uniform (fire climax).

Discussion. The attempts to arrive at an historical explanation of these prairie foundations, especially the so-called "general prairies," which were aimed at relating this to the weather fluctuations in the past 35a, 35c and 41b), unfortunately were based on preliminary geological studies. As far as the phylogenesis of the dominant types and groups is concerned, we can only say that the Gramineae and Cyperaceae are primitive families. They originated in the Liliflorae which, in turn, came from the same group as the herbaceous Dicotyledoneae (27).

On the basis of what we can find here today, we can say this: the prairies cover the poor and more or less level as well as irregularly drained land (10) found in the higher-elevated portions of the areas in which they predominate (62). This might perhaps enable us to tie them in with the shape of the relief, with the bare soil, or with the superficially impermeabilized layers, as well as with the type of drainage; these would be factors that would tend to inhibit the rapid rejuvenation of the soil; we can say this because we can find grassland and leaf forests of all types in the small pseudo-Karstic depressions of the plateau of Ponta Grossa (35a), as well as in the nascent and rejuvenated valleys in the prairie areas, and along the rivers, where the organic matter, humidity, etc, are combined to produce this effect.

Conclusions

In southern Brazil, we find, alongside with the forest (which is always humid in a rainy climate), the so-called wooded savanna and the prairie and, along with the latter (in a periodically dry climate), we find the forest-type of vegetation; the extent of these areas here is tied in more with "space" than with "time." This means that, in the rejuvenated areas, the forest manages to expand in just about any direction while in the older areas, the wooded savanna (in the deeper soil layers) and the prairies (in the superficially impermeable layers) likewise expand in just about any direction.

1. The broad-leaf forests here probably expanded from a rather recent rainfall period and they continue with full vitality:

(a) they cover the dark slopes, dominated by ciophilic elements, with heavy and phytogenetically more primitive seeds; the forest found along the slopes of the crystalline mountain ranges on the Atlantic Coast, along the southern portion, appears to reveal a rather older expansion;

(b) the forests cover alluvial terrain, dominated by heliophile species; here we find lighter and phylogenetically more developed seeds; the forests which are established in the drainage basins and along the coastal plains appear to indicate a quite a bit more recent expansion.

2. The pinna-leaf forest expanded with the drainage network of the southern plateau during a relatively recent period and it, likewise, continues to grow with full vitality:

(a) it occupies the recently rejuvenated areas of the prairie sections (depressions, water springs source areas, etc); this gives us a very clear outline for the current area covered by this type of forest;

(b) the area of overlap is indicated by the adult elements in an environment of broad-leaf species.

3. The savannas or prairies, originally restricted to the acid and poor soils (because of their geological origin), are rapidly occupying new areas because of the rather disorderly action taken by man here:

(a) devastation of forest areas on deep sandstones, where the semi-humid climate promotes laterization; here we find a creeping advance by the withered savanna-type of vegetation;

(b) devastation of forest areas on clayey formations, where erosion is rapidly exposing the semi-decomposed rocks; here again there is no resistance to the creeping occupation by the prairie;

(c) devastation of areas for the sake of agriculture and subsequent of pastureland, in any kind of terrain, where we have periodic fire; these areas will be forcefully occupied as a result of the "climax of fire."

4. As far as the historical past of the areas today occupied by certain types of vegetation are concerned, only a rather thorough analysis of the pollinic strata of the local peat bogs can definitely answer this question for us.

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(Use the information service of the National Geographic Council to clear up any doubts and to complete your information on geography in general and the geography of Brazil, in particular.)

FIGURE APPENDIX

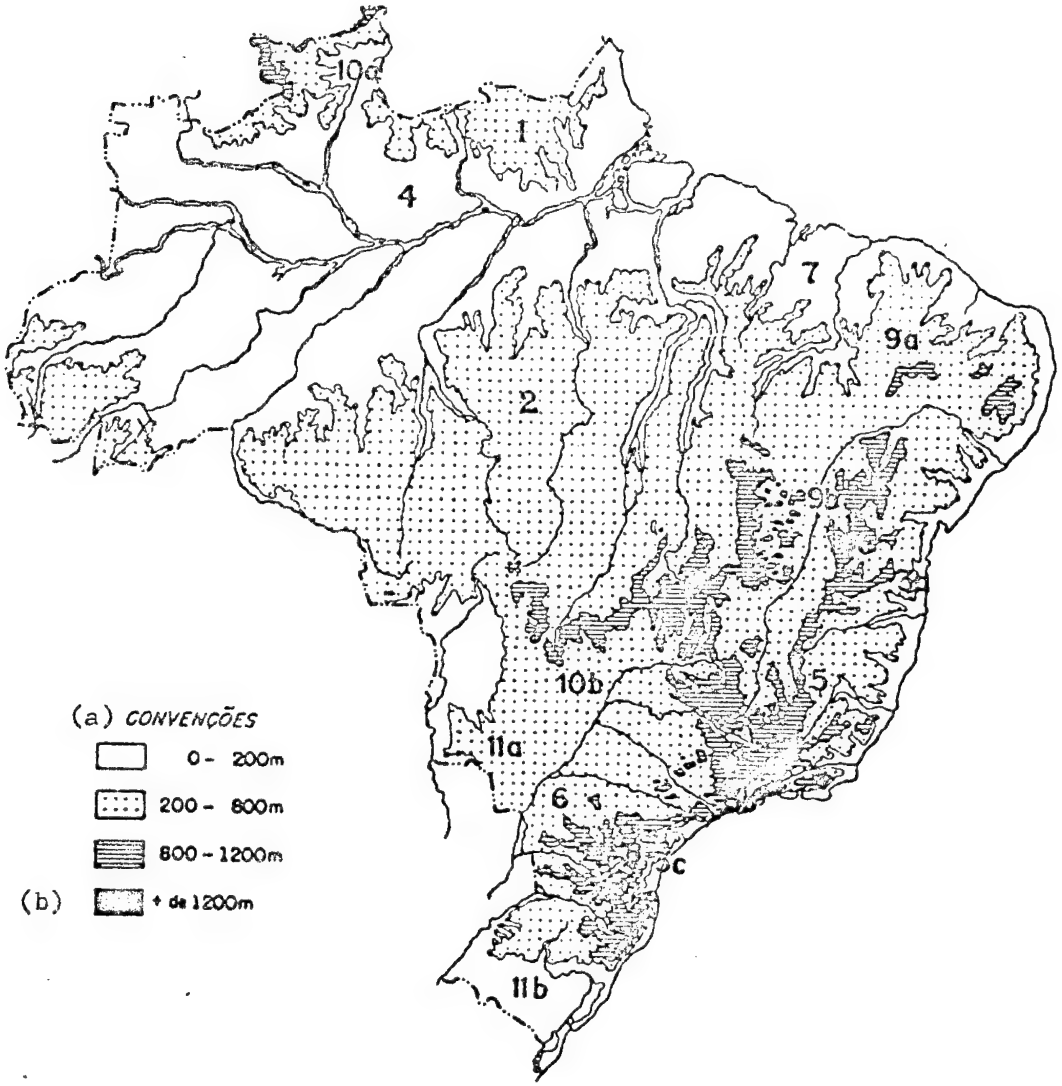


Figure 1. Distribution of the principal types of vegetation of Brazil, broken down by their dominant features.

Broad-leaf forests:

1. Guiana group (Lauraceae -- Sapotaceae).
2. Northern-Brazilian group (Lauraceae -- Meliaceae).
3. Eastern-Brazilian group:
   (a) south of Bahia (Lauraceae -- Leguminosae)
   (b) Orgaos mountain range (Lauraceae -- Vochysiaceae)
   (c) Mar mountain range (Lauraceae -- Magnoliaceae)
4. Amazon Basin (Leguminosae -- Lecythidaceae).
5. Eastern Atlantic Basin (Leguminosae -- Apocynaceae).
6. Parana-Uruguai Basin (Leguminosae -- Lauraceae).

Palm-leaf forests:

7. Maranhao-Piaui Basin (Palmae).

Legend to Fig. 1 (continued):

Pinna-leaf forests:

8. Southern plateau (Araucariaceae).

Savannas:

9. Scrub woodland:
   (a) northeastern depression (Euphorbiaceae -- Anacardiaceae)
   (b) Sao Francisco Basin (Euphorbiaceae -- Cactaceae)

10. Woodland savanna:
   (a) northern plateau (Dilleniaceae -- Caryocaraceae)
   (b) central-western plateau (Vochysiaceae -- Leguminosae)
   (c) eastern plateau (Caryocaraceae -- Apocynaceae)

Prairies:

11. Depressions:
   (a) southern part of Mato Grosso (Gramineae
   (b) southern part of Rio Grande (Gramineae -- Cyperaceae)

Legend: a -- elevation symbols; b -- more than.

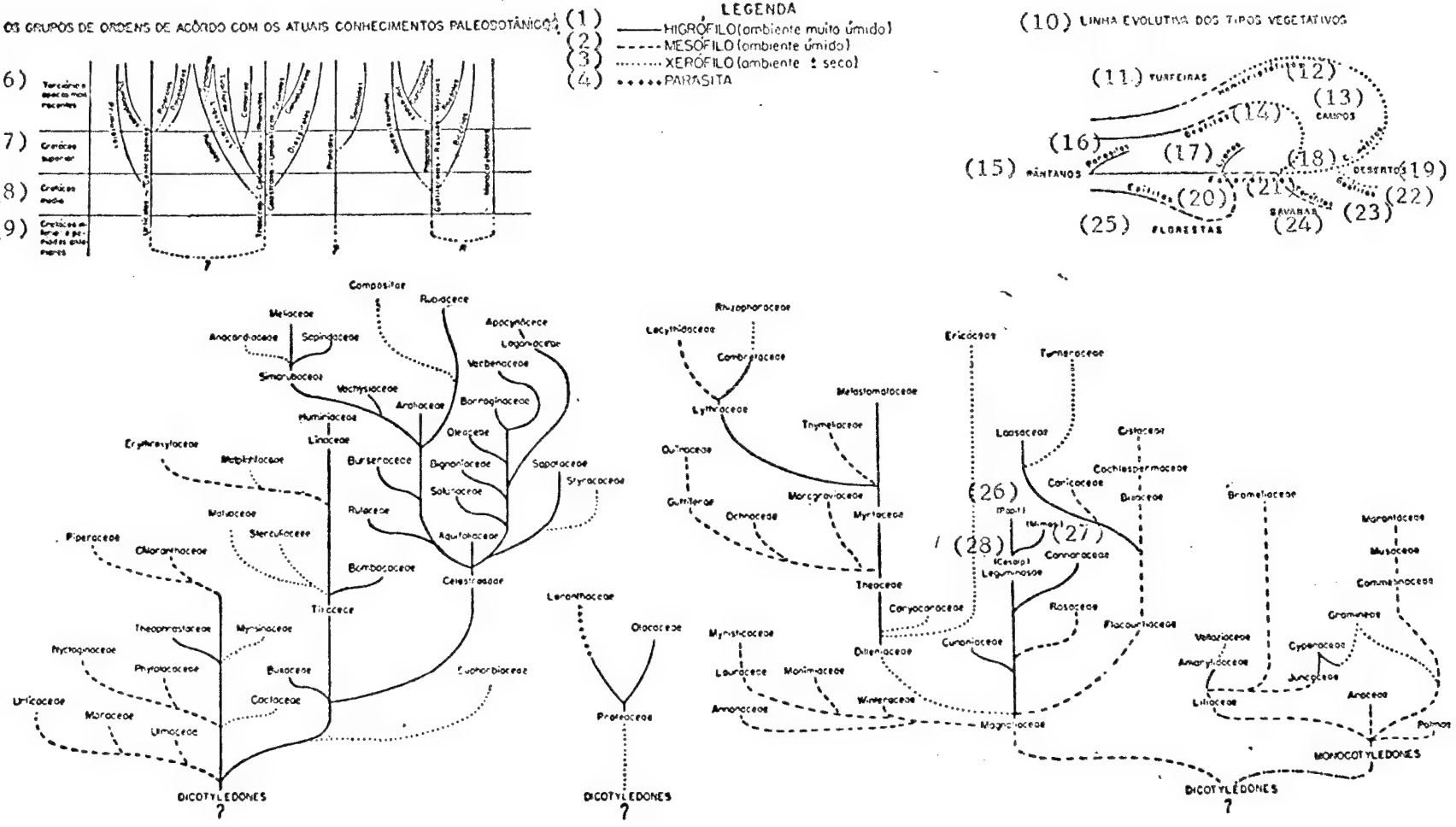


Figure 2. Diagram of hypothetical lines of development of the principal Brazilian families. Legend: 1 - hydrophile (very humid environment); 2 - mesophile (humid environment); 3 - zerophile (more or less dry environment); 4 - parasite; 5 - the groups of orders in accordance with present paleobotanic knowledge; 6 - Tertiary and more recent epochs; 7 - Upper Cretaceous; 8 - Middle Cretaceous; 9 - Lower Cretaceous and earlier periods; 10 - line of development of the vegetation types; 11 - peat bogs; 12 - hemicryptophytes; 13 - prairies; 14 - geophytes; 15 - lowlands [swamps]; 16 - parasites; 17 - lianas [climbing plants]; 18 - camephytes; 19 - deserts; 20 - epiphytes; 21 - fanerophytes; 22 - geophytes; 23 - terophytes; 24 - savannas; 25 - forests; 26 - papule; 27 - grasses; 28 - senna family.

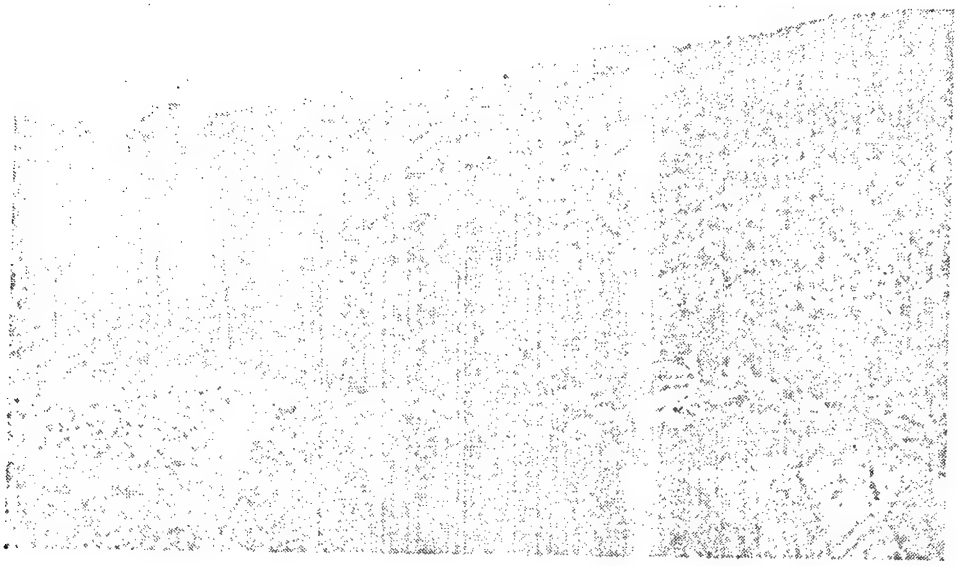


Figure 3. Partial view of the broad-leaf forest of the Basin of the Parana, in the vicinity of the mouth of the Iguacu.

Figure 4. Partial view of a group of Aspidosperma polyneuron in the vicinity of the Iguacu block.

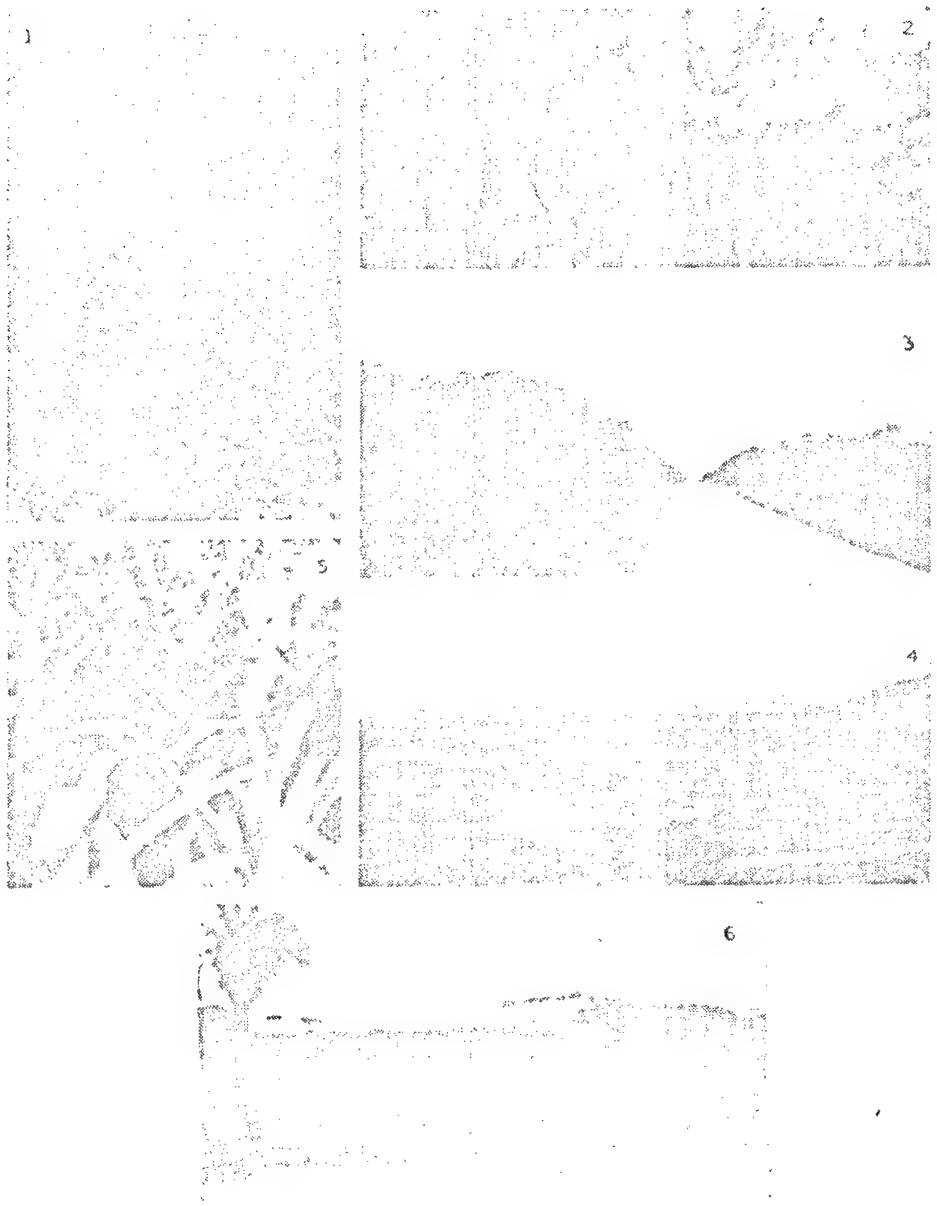


Figure 5. Partial views of the broad-leaf forest along the Atlantic Coast. Photo 1, Curitiba mountain range; Photo 2, branches of Ocotea catharinensis with epiphytes; Photo 3, maritime plain between Guaratuba (PR) and Porto das Canoas (SC); Photo 5, detail of the carpet of bromeliaceas, which is common to the entire area; finally, Photo 6, section of the wooded sand bar of Ararangua (SC), with still moving dunes, showing Butia capitata (the Brazilian butia palm).

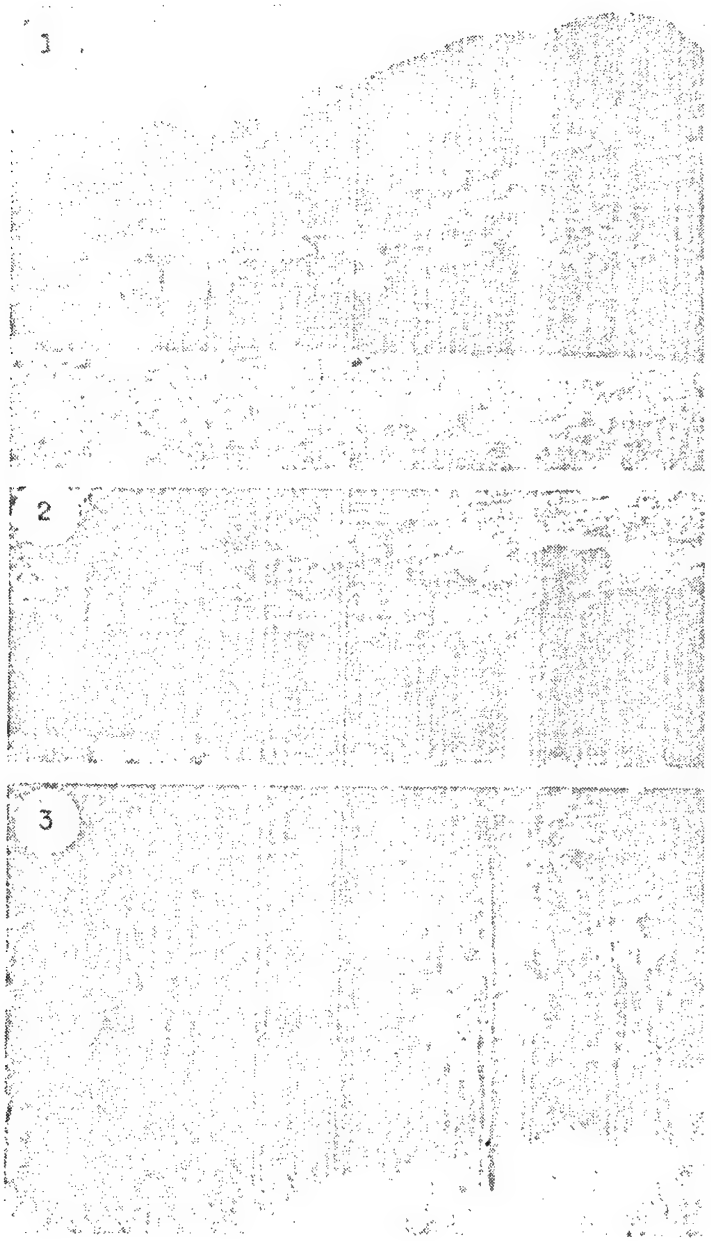


Figure 6. Partial views of groups of Araucaria angustifolia (Parana pine tree); Photo 1, small nucleus in the Mantiqueira mountain range (MG); Photo 2, detail of same picture; Photo 3, section of one of the countless groups in Apiai (SP), associated with Arecastrum ramanzoffianum (queen palm).

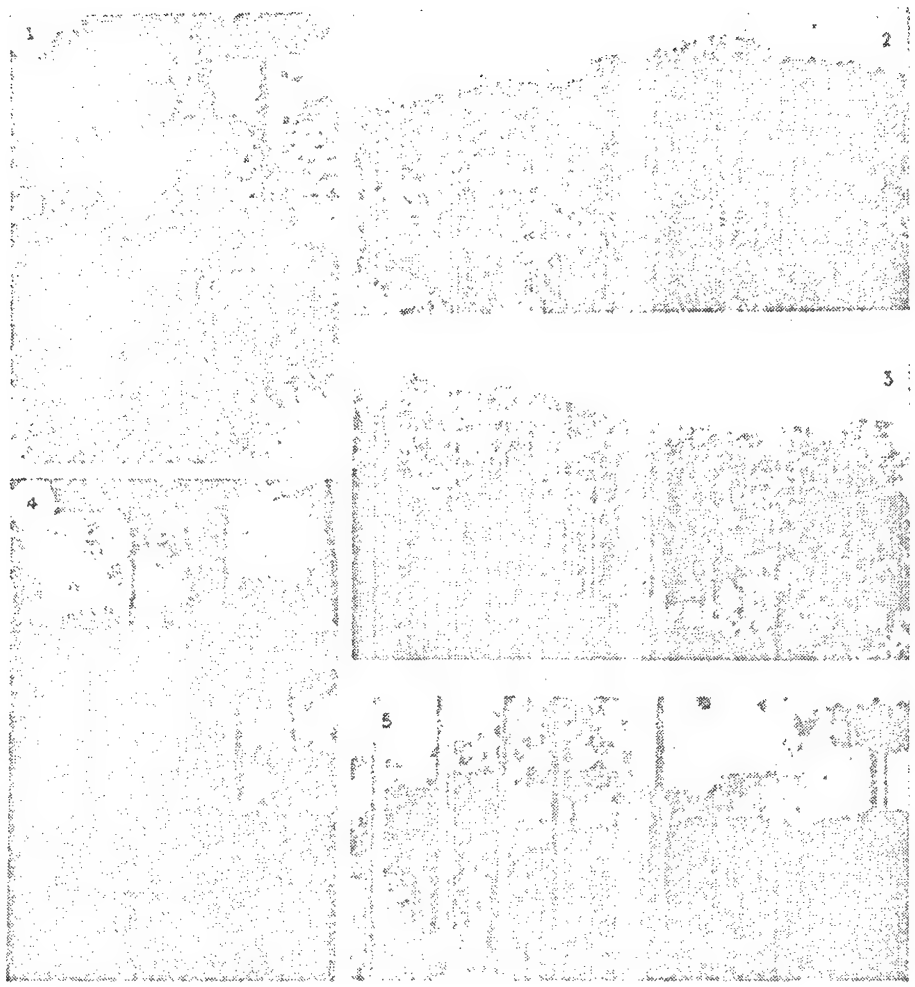


Figure 7. Partial views of the pinna-leaf forest; photos 1 and 2, the pine tree occupying the top of a hill and a detail of the same view, showing Dicksonia selloutana (Dicksonia fern), in certain stretches along the "block of the Urugui"; photos 3 and 4, pine trees standing along a slope, showing Podocarpus sellowi (pine tree), in the vicinity of Negrinho River (SC); finally, Photo 5, section of a pine tree forest situated between Majra and Lajes (SC), showing Butia criospatha (the Brazilian butia palm).

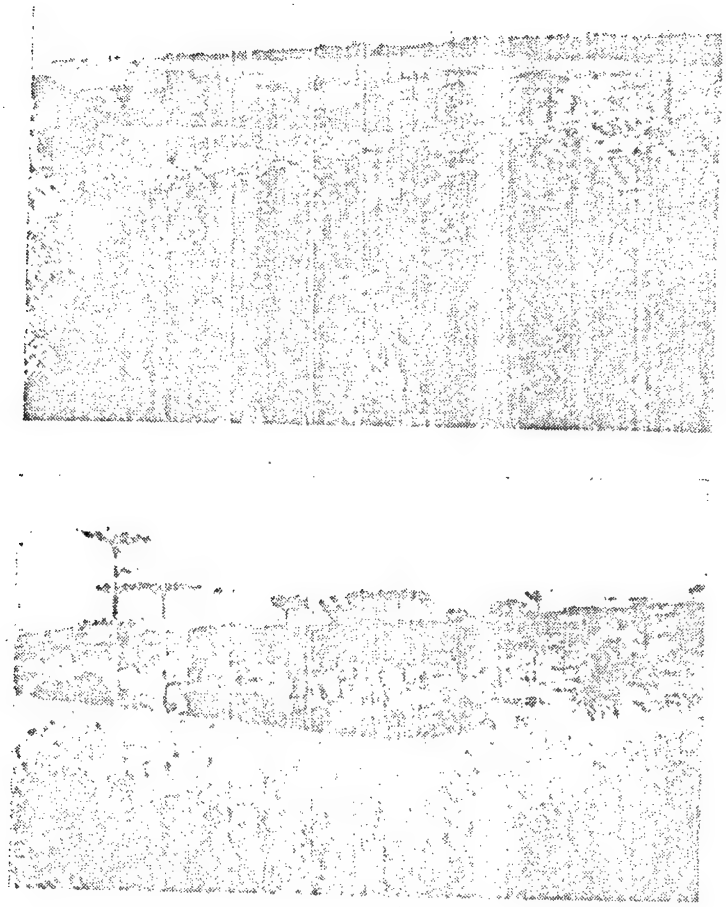


Figure 8. Partial views of clusters of pine trees in Guarapuava, showing the topographical situation.

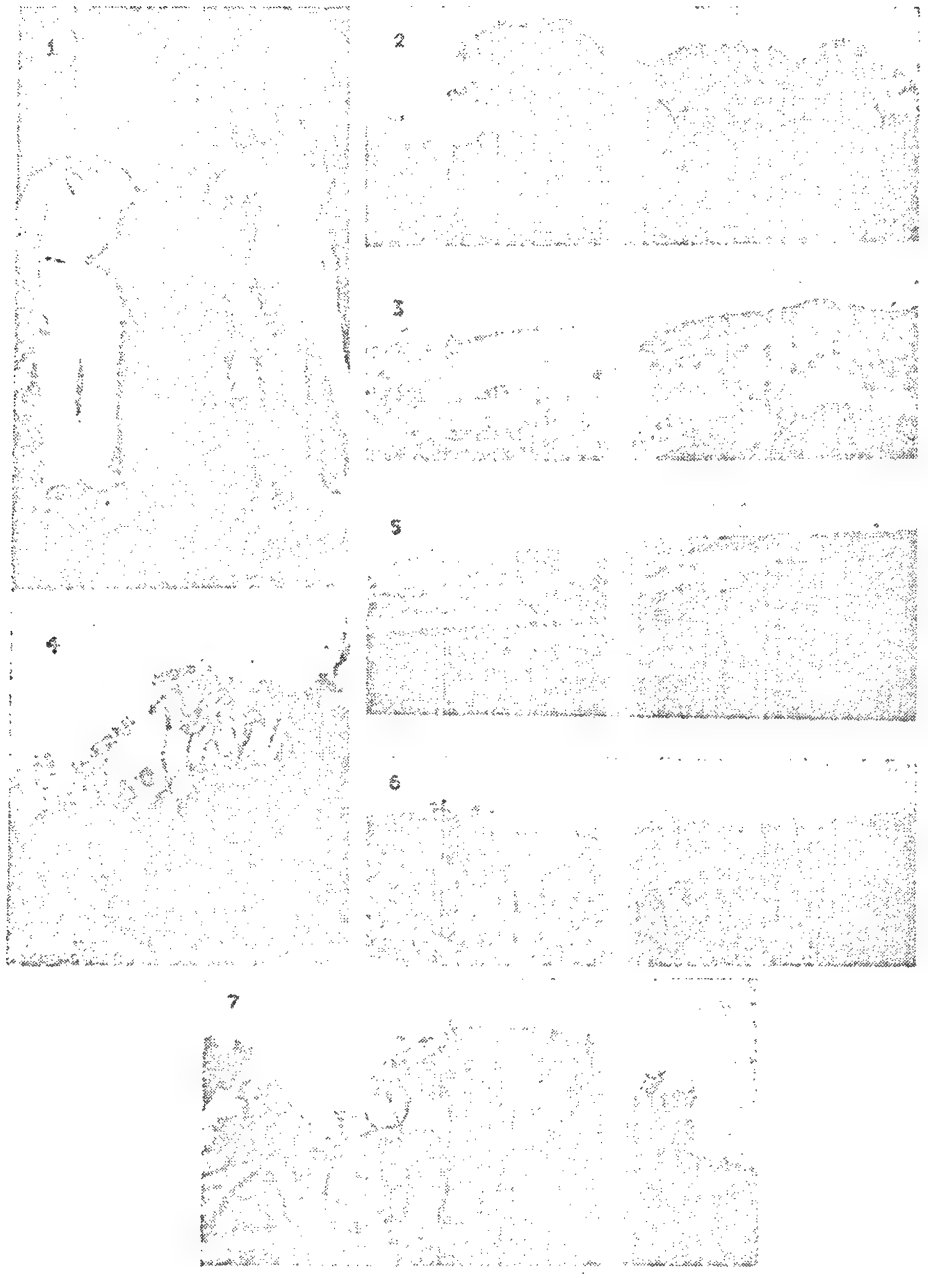


Figure 9. Partial views of the broad-leaf forest and the savanna in the vicinity of the Grande River, at Passos (MG); Photos 1 and 2, Aspidosperma sp., one of the dominant features in the local forest; Photo 3, rest of forest still occupying the top of a hill, surrounded by pastures of Melinis minutiflora (honey-colored grass); Photos 4 and 5, detail of woodland savanna dominated by Qualea parviflora and the outlier of sandstone where it dominates; Photos 6 and 7, section of the woodland savanna where fire occurs periodically and detail of this picture, with Dimorphandra mollis (the fuzzy faveiro).

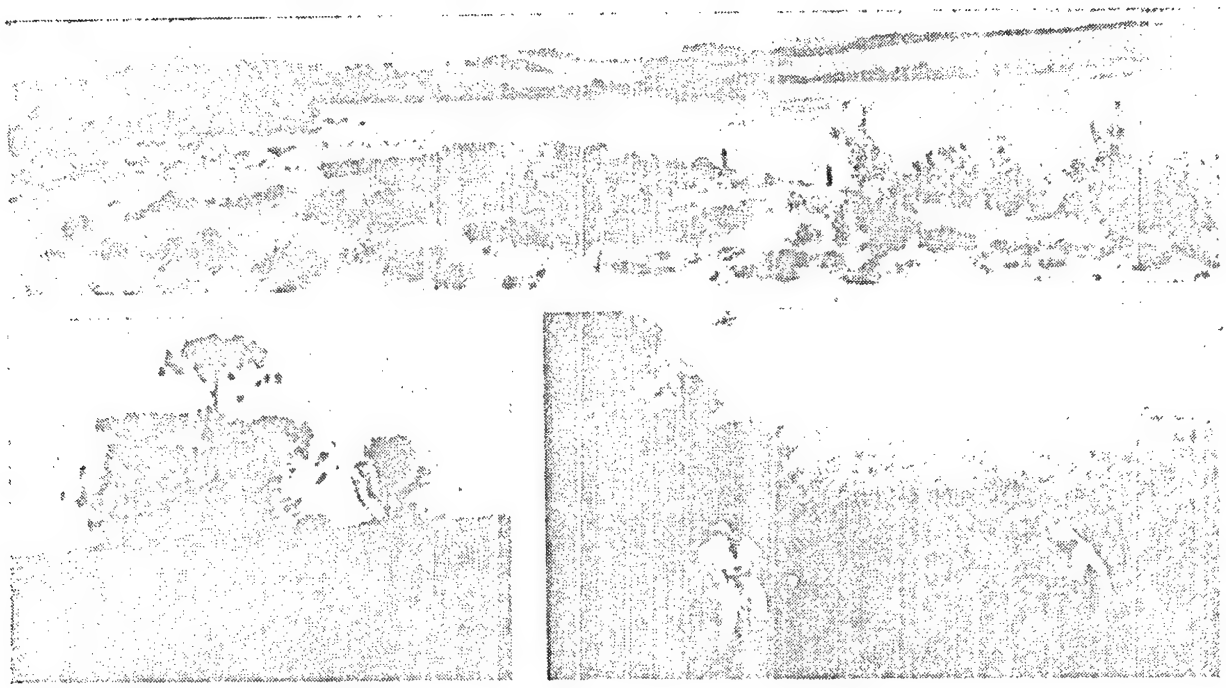


Figure 10. Partial views of the "general prairies" of the southern plateau; the first photo shows a panoramic view with the pine tree forests occupying the eastern slopes, depressions, and stretches along the streams, in the latter; here we can also see a clump of pine trees situated in a "pseudo-karstic" depression, showing, in detail, the difference in the elevation between the prairies and the pine tree clumps.

On the Waters and Soils of Brazilian Amazonia
(pp 195-202)

H. Sioli and
H. Klinge, Hydrobiology Institute of the Max Planck Society, Plon/Holstein
(Professor Dr Harald Sioli, General Manager)

(Translation by Jose Carlos Pedro Grande.)

So far, edaphological research on Brazil and particularly on the Amazon region has been conducted on a rather small scale. This kind of research frequently is not at all as detailed as it should be (the guide book for the trip through Amazonia for the 18th International Geography Congress in Rio de Janeiro [by Castro Soares, 1956, p 56] indicates the occurrence of laterites and "black earth" only in a very hasty fashion [see page 207]); other works are available only on a very restricted basis (Marbut and Manifold, 1926, Paiva Neto and others, 1951, Vieira and S.P. Filho O.J.). The most recent map of the soils of South America (Bramao and Lemos, 1960) enables us to recognize, in Amazonia, latosolic soils, gley soils and laterites with water in the subsoil; like a "world soil map" (based essentially on W. Holstein, Maull, 1958) which essentially indicates laterite -- this map does not indicate the podsolic soils which, on the basis of our knowledge, are very characteristic for some places here. Other authors likewise (Gourou, 1950, Teixeira Guerra, 1955) exclusively mention the Amazonian laterites. A knowledge of the soils of Amazonia however involves all of the natural sciences; we must expand our knowledge here partly also in the interest of agriculture and forestry; we are dealing with a vast gigantic area along the Amazon here and we must not allow any mistakes to be made here due to improper identification and we must not allow any losses to occur, losses which could not be made up for and which would cause the devastation of this last reserve which so far has not been touched by man (H. Bluntschli, 1921, was the first to recognize the nature of Amazonia as a "harmonious organism").

For purposes of comparison, we might look at a series of studies on the soils which to some extent are more detailed and more modern and deal specifically with tropical Central and South America (Durr and Klinge, 1960, Frei, 1958, Klinge, 1960 a-f, Schaufelberger, 1954, Vageles, 1939/1960, see Ganssen, 1957); in this connection the following works are particularly important: the work covering Surinam, near Amazonia (Bakker, 1951, 1954, 1957, a, b, Bakker and Muller, 1957, Schulz, 1960); these studies extensively confirm the results obtained in Amazonia. We also have a study on Borneo (Richards, 1936) which for the first time described the associations of certain soil types and water which are also found in Amazonia and which might perhaps be found in all of the tropics.

Our concern with the soils of the Amazon was brought about by numerous indications coming from limnology and from the chemical behavior of the water of the Amazon region; this enabled us to draw certain conclusions as to the nature of the soils in the regions involved here (Sioli, 1954, a, b, 1956, a, 1957, a, b)(H. Sioli recently, in 1959-1960, again visited this

region after many years; he had spent quite some time in Amazonia together with W. Sattler; in addition to bringing along samples of the water and biological material collected there he also brought soil samples and rock samples from 60 profiles of soils with subterranean water and surface soils [for the location of these profiles, see Figure 1]; these samples are currently being studied by our institute and we will prepare a report on this although we will not follow any strict sequential order here).

The major portion of Amazonia is occupied by a tropical rain forest with tall trees, the so-called tropical rain forest of A. von Humboldt; here, clustering in certain regions, we can find clear forests (more or less thinly overgrown with trees) and savannas with a few isolated clusters of trees; these have attracted the interest of natural scientists for quite some time (Huber, 1910, Paffen 1955). We neither can nor want to go into a discussion here on the "problem of the savannas" of Brazil (Lauer, 1952); we would like to confine ourselves exclusively here to some limnological notes and to some observations on the valleys.

As far as the savannas with the Aw climate are concerned (according to Koppen), in tropical America, that is, we find predominating the so-called black clay soils ("black clay," "black earth") which are also called "regur, thyrs, black cotton soil or grumosol (Frei, 1958, Klinge, 1960 d, Schaufelberger, 1952, 1955, 1956); in the savannas of Amazonia we almost always find dark brown sandy clay sometimes quite standardized. Regur soils can also be found in some of the drier portions of the region (Ruellan, 1957). One botanical property that is commonly found in many savannas of Amazonia and in the neotropics is, above all, in spite of the greatly differing edaphic conditions (the thyrsus, partly standardized soils), the occurrence of the Curatella americana tree among them (Lauer, 1954, Lotscher, 1953, Takeuchi, 1960).

In a type of forest called the "scrub woodland," which corresponds to the wallaba forest in Guiana (Richards, S., 1957, p 237), we find, in Amazonia, typically developed podsolic soils, up to a thickness of a few meters; like the dark brown podsolic clay soils, fully justify the conclusions arrived at by H. Sioli in his water research project. The thickness of the pale horizon of the typical podsolic soils, which usually ferro-humous podsal, may amount to several decimeters (according to a verbal communication from Father Placidus Toelle , O.F.M., Mission of Sao Francisco, the discolored sands here are called "cauigerita" and the local rocks are called "caui" -- meaning hard earth). the other A sub-horizons are much thinner; we also find A_H horizons which are very weakly humous and which therefore have rather ashen and clear-ashen color. Occasionally we can also find rather pale sands under a cover of acid humous, when the excavations or drillings could not be kept up to a sufficient depth. In one case we found a rather thin layer of peat.

In the "wallaba" forest with "eperua" [the soft wallaba tree] we can also observe podsolic soils and P.W. Richards also found podsols in a forest in Borneo similar to this one. The podsols in the following other neotropical countries have been described: Colombia (Jenny, 1948); Surinam (Bakker, 1954); Peru, Amazon region (Ellenberg, 1959), and E.C.J. Mohr and F.A. van Baren, 1959, page 398; these authors described the podsolic soils of the other lowlands plains of the tropics.

According to the literature on the subject and on the basis of our own observations, we might expect and to some extent we have already recognized a definite relationship between the soil types, the types of water, and the plant associations which, in future field work, should be analyzed in great detail. We must devote special attention to the economy of the water in each form of habitat because this is a decisive criterion here. On the basis of the phytosociological classification of Amazonia (Table 1) and the description of the various plant associations which are not yet satisfactory and especially because the customary terms are not applied in this country to frequent associations that are often quite differentiated, we cannot go into this group of questions unless we make further field studies in cooperation with phytosociologists and/or geo-botanists.

One rather disturbing factor in research of this nature is of course the action of man in these areas; we cannot possibly get a sufficient idea of the extent of human action in the pre-European indigenous population settlement areas. The "black earth" which is also called "the earth of the Indian" and on which we find growing tall forests, is a soil formation which owes its present-day structure -- in the form of a dystrophic humous on a horizon of brown clay and red clay ("purple earth") -- undoubtedly to an ancient indigenous (cultural) civilization; because of the enrichment with organic matter from the podsolic horizons, these soils might possibly have originated during the utilization of the soil as such; this would be the horizon of humous types comparable to the Esch soils in the northwestern part of Europe (according to a very kind communication from Father Protasius Frikel, O.F.M., or Father Placidas Foelle, O.F.M., these organic materials were probably added in the form of sweepings, remnants of food, and the left-overs of human habitations; "the black earth is a favorite place for archeological finds"; Hilbert, 1955, Sioli, 1956). The occurrence of savannas on weakly podsolized soils is quite possible here and this indicates an anthropogenically influenced development in these areas; in other words, we started out here with a tall forest; gradually we find savannas developing on the non-podsolized brown clay; this, it seems, also happened in the case of the plains along the lowlands of the Orinoco (Richards, 1957, pp 323, 327, Vageler, 1939/1960); these can therefore be considered natural savannas. On the scrub woodland areas along the Negro River and in the prairies which are at least temporarily covered with genuine podsolic soils -- which were probably never a region of human habitation -- it is the flooding of the area and not the vegetation cover which would appear to be responsible for podsolization.

In tropical Central America, where we have a changing humidity to this very day, even in a cold-humid situation in the mountains, we do not know of any podsolization that did not upset the clay layers; this is called leaching and this appears to be tied in with certain humid and high-elevation areas, where the forest is so high up that it is partly covered with mist and fog, especially when we have a northern exposure, as in the case of El Salvador (Klinge, 1960 b).

TABLE 1

IMPORTANT PLANT ASSOCIATIONS IN AMAZONIA (ACCORDING TO DUCKE AND BLACK, 1953 AND ON THE BASIS OF OUR OWN KNOWLEDGE)

Type of Vegetation	Name Given in Particular Country	Soil	Climate and Observations
Mangrove	Mangrove	Sub-hydric soils	Afi/Awi -- abandoned by the low tide twice a day; belongs to western"mangrove"
Inundation forest	Swamp forest	Flood plain soils(?) (flood plain)	Afi/Ami -- Wet almost the year round
Grass prairie [fields]	Flood plain prairie	Prairie soils	Ami -- only along the lower Amazonas, in low-level flood territory; periodically flooded
Wooded sand bar	Wooded sand bar	--	Ami -- Almost never reached by floods
Clear forest	Scrub woodland (*)	Podsol	Afi -- low humid forest (wet); ericaceas and vaciniaceas are frequent
Clear woods (savanna)	Plains -- plain or prairie along the southern boundary of Amazon rain forest	Podsol	Ami -- similar to prairies which are typologically like scrub woodland; Ilex, ericaceas, vaciniaceas, ciperaceas cladonia are frequent here
Tropical rain forest (Amazon rain forest) tall rain forest of Amazonia	Firm-ground forest	Brown clay; brown lateritic clay	Afi, Ami
Tropical rain forest (Amazon rain forest)	Firm-ground forest	Podsolized brown clay ("black earth," Esch soils, "black earth")	Afi, Ami -- land of the pre-Colombian natives along the edges of the firm ground (Hilbert, 1955)

Table 1 (contd)

Secondary forest	Second-growth scrub forest	Miscellaneous forms of brown clay	Afi, Ami -- when sufficiently clear, very often looks like Amazon rain forest to the point where certain phytosociological differences in the destruction of the forest due to fire or forest clearing might be confused
Grassland (humid savanna according to Troll (1956)	General prairie	Brown clay and podsolized brown clay	Awi

(*) Not to be confused with the scrub woodland of the arid zone of northeastern Brazil; known to exist only in the region along the upper course of the Negro River and along the Solimoes River, in the vicinity of Sao Paulo de Olivenca (verbal communication from Mr Ricardo de Lemos Frois); decreasing moisture due to influence of flood water on subsoil or dammed-up water.

The development of podsolic soils on rocks of appropriate origin is perfectly understandable in the always moist scrub woodland but not in the dry savannas, whereas, in the savannas of Amazonia, the podsolization can be explained as a consequence of the periodically high water level. In the brown silico-clayey mud (clay)of northern Brazil (especially archaicum [azoic rocks] with granites and gnisses), which form on the very ancient peneplain that covers this basic mountain [bed rock], the poverty of the soils in nutritive matter is somewhat made up for by the luxuriant vegetation of the virgin forest; this also applies to the brown clay in the Tertiary sediments of the Amazon sweet-water lake, wherever it is found on firm ground. The abandonment of the fields ("clearings"), after they have been used for only 2-3 years, clearly shows that the soil here is not worth much from the farming viewpoint and it can be restored to possible further use only after several years of rest, before it is worth while to farm again (Camargo, 1958, Ellenberg, 1959, Sioli, 1956 b, 1957 b). In the nutritive matter accumulated in the tropical climax forests [sic] circulate especially immediately between the humus cover and the forest vegetation as such; in the forest clearing and on the subsequent farm or plantation land, we can therefore, under certain circumstances, anticipate podsolization; this gave us the idea of the "primary and secondary savannas of Amazonia" (see Rawitscher, 1946, 1949/1950).

(Our knowledge of the paleopedology of Brazil is extremely spotty; (Bakker, Kiel and Muller, 1953, Camargo 1960, Sakamoto, 1958.)

The podsolic soils of Amazonia (and we have samples of these with us) like the well-formed Bz and Bs horizons in some cases are superposed on strata of brown clay which are partially also included in the B horizon. The rocky subsoil here frequently consists of ancient granites (see the 1938 geological map) on which the previously mentioned pleneplain was formed; for this reason -- and because of the occurrence of the typical podsol here -- this should also be considered a factor responsible for the old age of these localities (here we must also mention the sandstones, possibly Cretaceous, along the southern edge of the Amazon rain forest, along the Cururu River and in the Cachimbo mountain range, as well as the older Devonian sandstones of the Arinamba (?) prairie to the north of the lower Amazonas). In the Amazon rain forest, away from the savannas, we mostly find "brown caly." Without any special research on the soil here, we could not say whether the brown clay layers, below the podsol, involve remnants of a cover of brown clay which was exposed to secondary podsolization or a layer of brown clay on which sand was superposed; Vieira and J.P. Filho O.J. thought that the latter was the case in a study on the scrub woodland of the upper course of the Negro River. I.P. Bakker (1954) also found podsolic soils on marine sands along the coast of Surinam and P. Vageler found the same along the southern coast of Brazil; H. Sioli also made similar observations in the region of the mouth of the Amazonas River.

Oddly enough, the podsolic soils of Amazonia, in spite of their high degree of humidity, are almost always seeming to lack a cover of coarse humus and, in the majority of cases, we do not even have a A_H horizon, which consists in rather poorly colloidal humus between the whitened quartzes; this is why the podsolic soils frequently stand out in the form of clear [bright] areas. But even in view of the high rate of mineralization of the surface, under high temperatures and with the rather good moisture in the Amazon localities, we could not exclude the possibility of erosion of the upper sub-horizons of the humous layers; considering the rather small percentage of vegetation cover in these localities, this becomes increasingly understandable (Bakker, 1954); along the scrub woodland areas following the upper course of the Negro River, the layer of humous is usually found in a complete pattern. But even a hidden erosion, with slightly podsolized brown clay, in the forest, could -- over long periods of time -- cause an accumulation of discolored sand in the terrain depressions on top of which podsolic soils might form (Vieira and J.P. Filho O.J.).

In Amazonia, the principal drainage river in one of the most typical regions of podsolic soil distribution, is the Negro River; it is called that because of its dark and humous waters which come from podsolic soil areas; these waters have been called "brown [dark] waters" (Schwarzwasser [Black waters]). Other rivers in Amazonia, which come down from the Andes, where brown clay is formed in the major portion of the area, bring muddy waters along with them; rivers coming from regions with a more or less uniform and gentle relief (a relief that is not at all broken up) and where we have brown clay contain clear water. The muddy color of many water bodies in Amazonia should therefore not astonish us in view of the vast distribution of brown clay; even when they are buried with surface drainage, in these regions, they take on the (greenish-ashen) color of pea soup, after a short downpour (Klinge, 1960 c, Kubiena, 1957/1958). H. Sioli was the first to understand these three types of water in their regions of origin and to grasp the environmental conditions prevailing here (Tables 2 and 3).

Small rivers with muddy water are undoubtedly very rare, for example, the Tinga River, during the rainy season, and little brooks with muddy water, were not observed at all here; this is so because their existence requires a more heavily cut relief than the relief we generally find in Amazonia.

TABLE 2

Types of Rivers	Color of Water	Region of Origin	Soils	Vegetation	Examples
White water	Yellow color of mud or clay	Andes, Parima mountain range, etc.	Brown clay	High Andes forest	Amazonas, Madeira River

Types of Rivers	Color of Water	Region of Origin	Soils	Vegetation	Examples
Clear water	Yellowish-greenish, olive-colored, clear, transparent	Massif of Central Brazil and the Guianas, Tertiary firm ground of Amazonia	Brown clay	Amazonian tall forest	Tapajos, most of the brooks (small water bodies) on Tertiary firm ground
Black water	Dark olive, coffee-colored, transparent	Plains in general	Podsol	Scrub woodland, fields on prairies	Rio Negro, Rio Cururi, a stream which has its sources in the fields [prairie]

TABLE 3

AVERAGE CHEMICAL COMPOSITION VALUES FOR THREE AMAZON WATER TYPES (BASED ON PUBLISHED AND UNPUBLISHED DATA OF H. SIOLI)

(1) TIPO DE ÁGUA	pH	P mg/l	Al mg/l	Mn mg/l	Fe mg/l	SiO_2 mg/l	N_2O_5	NH3-Epeldahl mg/l	(2) Condut. de $KMnO_4$ mg/l	(3) Localidade	(4) Fonte de informações
(5) Água preta ...	4,1	—	+	—	0,15	3,0	0	+	92,3	(6) Corrego à embocadura Catari-Uaupés no rio Negro	Sioli, 1954a
	4,2	0	Vestg	0	0,10	1,0	0	0,3	113,8	(7) rrego (17) Zona Bragantina	Sioli, 1957b
	4,2 a 4,3	—	Vestg	—	0,10	2,5	0	—	71,3	(8) o Negro, perto de Içana	Sioli, 1956a
	3,8	0,157	—	0,012	0,24	2,6	0,069	1,16	—	(9) Lacrimal no rio Içana	Sioli, inédito
	3,8	0,013	—	0	0,19	1,7	0,017	1,42	(10)	Água de subsolo em Caatinga da Ticundari	Inédito (11)
(12) Valores médios	1,6	0,157	Vestg	0,012	0,24	3,0	0,060	1,46	70		
(13) Água clara ...	5,2	-	0	-	0,03	3,5	0,2	0	3,9	(14) Corrego à embocadura Cuiari-Uaupés ao Rio Negro	Sioli, 1954a
	4,6	0	0	0	0	4,5	0,8	0,10	9	(15) rrego (5) Zona Bragantina	Sioli, 1957b
	6,5	0	0	0	Vestg	5,0	—	0,15	15,15	Rio Tapajós perto de Belterra (16)	Sioli, inédito (11)
(17) Valores médios	1,6 a 6,6	0	0	0	0,03	3,5 a 5,0	0,2 0,8	0,15	15,5	-	(11)
(18) Água branca	6,9	0	0	0	0,58	6,0	0,28	Vestg	21,39	Amazonas, Santarém	Sioli, inédito
	6,5	Vestg	0	—	0,56	—	0,14	—	4,6	Amazonas, Santarém	Sioli, inédito
	7,2	0,115	0,02	0,250	5,1	8,3	0,031	0,67	—	Rio Madeira, curso inferior (19)	Sioli, inédito
	7,25	0,092	0,01	0,081	3,05	12,4	0,026	0,50	—	Rio Solimões, em Sto. Antônio do Içá (20)	Sioli, inédito (11)
(17) Valores médios	6,5 a 7,25	0,185	0,01	0,250	5,1	12,4	0,28	0,67	21,4		

Legend to Table 3: 1 - type of water; 2 - consumption of; 3 - locality; 4 - source of information; 5 - black water; 6 - brook at the mouth of Caiari-Uaupes into Negro River; 7 - Brook (17), Bragantina zone; 8 - Rio Negro, near Icana; 9 - Lake along Icana River; 10 - subsoil water in scrub woodland of Ticundari; 11 - unpublished; 12 - average values; 13 - clear water; 14 - brook at mouth of Caiari-Uaupes along Negro River; 15 - brook (5), Bragantina zone; 16 - Tapajos River near Belterra; 17 - average values; 18 - white water; 19 - lower course; 20 - at.

TABLE 4 A

SEDIMENT LOAD CARRIED BY AMAZONIAN RIVERS DURING RAINY AND DRY SEASON

	(1) ESTAÇÃO CHUVOSA			(2) ESTAÇÃO SÊCA		(6)
	(3) Partículas suspensas em/l	(4) Perda ao rubro em %	(5) Substância orgânica suspensa em/2	(3) Partículas suspensas em/2	(4) Perda ao rubro em %	Fonte
Amazonas (Maicuru)*						
(7) Estação I — Superfície (8)	0,1658	9,4	—	0,067	13,4	
mais fundo (9)	0,1778	10,3	—	0,8198	8,4	
(7) Estação Is — Superfície (8)	0,1552	11,0	—	0,0646	10,2	Sioli, 1957 a
(7) Estação II — Superfície (9) (8)	0,1251	10,5	—	0,1029	7,1	
mais fundo (9)	0,1047	8,3	—	0,0745	12,1	
(7) Estação IIs — Superfície (8)	0,1031	9,9	—	0,0816	10,6	
Amazonas (Óbidos 1) 2)						
a) 0,5m de profundidade (10)	0,1966	0,1362	0,0614			Katzer, 1903
b) 26,0m de profundidade (10)	0,1001	0,0532	0,0572			
Tapajós (Itaituba 1) 2						
0,5 a 1m de profundidade (10)	0 0912	0,0284	0,0628			
Amazonas (Maicuru)						
a) Canal (furo), 400m da margem (11)	0,1281	9,8	—			
b) O mesmo furo, 4 km distante da margem do rio (12)	0,0209	22,9	—	(13)		
Amazonas 1) 2) (Óbidos)	618,155 × 106 de t/ano de material suspenso + dissolvido					Katzer, 1903, p. 46
Xingu 1) 2) (Pôrto de Moz)	0,0875	0,0312	0,0563			Katzer, 1903, p. 45

Legend: 1-- rainy season; 2-- dry season; 3--suspended particles; 4--loss to red[clay] in %; 5-- suspended organic substance; 6 -- source; 7 -- station; 8-- surface; 9 -- bottom; 10--depth; 11-- channel (between lake and river), 400 m from banks; 12 -- same channel, 4 km from river bank; 13 -- tons per year of suspended and dissolved material; (*) Average values derived from various averaging operations; (1) No indication as to season of year; (2) Does not indicate loss to red [clay] plus weight after examination, in g/l; (3) Report by Lams (1945), quoted by Richards (1957, page 207), although 1-2 million kg per year would, by comparison, appear to be too high a figure.

Note: Along the Tapajos and Xingu we are dealing with clear water whereas on the Amazonas we have white water that has been contaminated by dark and clear water.

TABLE 4 B

CHANGES IN THE CHEMICAL BEHAVIOR OF THE AMAZONIAN RIVERS DURING RAINY AND DRY SEASONS

(1) RIOS	AMAZONAS		TAPAJÓS								
(2) Localidade	Santarém		Itaituba	Santarem		Belterra					
(3) Profundidade	Am		Superf.	Superf. 27m		0,5m	15m	(12) Superficie			
(4) Estação do ano	(13) Séca 1946	(14) Agoas 1948	(12) Séca 1946	(12) Est. de águas 1948		(15) Est. de águas 1946		(13) Séca 1947*	(15) Est. de águas 1948*		
(5) Mês	Junho (6)	Março (7)	Agôsto (8)	Março (7)		Junho (6)		Nov. (9)	Fev. (10)	Março (7)	Maio (11)
pH	6,5	6,9	6,6	6,5	6,5	6,5	6,5	6,65	6,6	6,4	6,55
(16) O^2 dissolvido mg/l	—	7,17	—	9,21	8,09	6,86	6,83	8,70	6,89	6,85	7,22
(17) CO^2 livre mg/l	3,95	7,15	0,71	3,0	3,1	0,88	0,88	0,80	3,0	3,5	2,5
(18) Bicarbonato CO^2 mg/l	11,15	—	6,0	3,14	3,14	2,69	—	5,2	3.		
(19) Dureza global °DGH	0,64	1,27	—	0,77	0,75	0,13	—	0,40	0,31	0,82	0,67
Fe (global) mg/l	0,36	0,38	—	0,08	0,12	0	—	0	Vestg	0,1	Vestg
Al mg/l	0	0	—	0	0	0	—	0	0	0	0
Mn mg/l	—	0	—	0	0	—	—	0	0	0	0
(20) NH^3 livre como Mg NH_4/l	—	Vestg	—	0,13	0,12	—	—	—	0,18	0,07	0,15
Cl mg/l	0	0,30	—	0,30	0,05	0,67	—	0,60	0,10	0,20	0,20
SO^4 mg/l	2	0	—	0	0	2	—	0	0	0	0
NO^3 mg/l	0,16	0,28	—	0,01	0,08	0	—	0,03	0,3	0,03	Vestg
PO^5 mg/l	Vestg	0	—	0	0	0	—	0	0	0	0
(16) SiO^2 dissolvido mg/l	—	6,0	—	5,4	5,0	-	-	6,5	5,5	5,6	5,0
(21) Consumo de $KMnO_4$ mg/l	19,25	21,39	6,08	2,07	2,07	8,93	—	12,70	25,08	22,05	15,46
(22) Ácidos húmicos polivalentes(*)/l	—	0	—	0	0	—	—	-	0	0	0

Legend: 1-- rivers; 2 -- locality; 3 -- depth; 4 -- season of year; 5-- month; 6 -- June; 7 -- March; 8 -- August; 9 -- November; 10 -- February; 11 -- May; 12 -- surface; 13 -- dry season; 14 -- rainy season; 15 -- rainy season; 16 -- dissolved; 17 -- free; 18 -- bicarbonate; 19 -- over-all hardness; 20 -- free in the form of; 21 -- consumption of; 22 -- polyvalent humic acid [soils]; (*) analyses according to R. Braun.

The nature of the material found in suspension in the rivers varies in terms of quantity and quality during the seasons and the variation is by no means insignificant (Tables 4A and 4B).

According to indications received so far, it seems that, in Amazonia, in addition to the podsolic soils, we have a preponderant occurrence of brown clays which, however, can also be reddish in color although they do not extend to the typically red colors which we find in central and southern Brazil in the form of the "purple earth" (Ganssen, 1957; Vageler, 1939/1940). Very often, however, in one way or another, we can find concretion horizons in the brown clay with a percentage of iron, sometimes also indicated as laterite (the customary term in Brazil is "canga"). We are not quite sure whether we are dealing here with "legitimate laterites" or "subsoil water laterites." The rather high content of silicic acid in the waters of these regions at least demonstrates a mobility that is higher than that of the silicic acid in the soils and this thus enables us to assume some degree of laterization (Kubiena, 1956). However, the dark waters likewise reveal more insignificant contents of silicic acid.

In addition to the autochtonous soils mentioned so far, Amazonia also reveals a rather vast area of soil sediments [sedimentation soils], preferably in the white water territory (Sioli, 1957 a). Considering the difference in the load of material in suspension, carried by the three types of rivers (Table 4), it is no wonder that we find sediments especially in the mud-carrying white water territory; because of the water level in the subsoil, which is high almost throughout the year, and because of the periodically regular floods, these sediments are shaped up here in the form of flood plain soils (gley). On this kind of sedimentary terrain we now find the "flood plain" building up as such (Table 1, Vageler, 1949); its forests here should not be confused with the flood forests of the swamp forests which are found in clear and dark water regions. Along the Atlantic Coast, where the water of the Amazonas is influenced by marine currents quite a bit to the north, we find mangrove depressions in quite a few places.

Summary

The limnological studies have given us the first specific indications on the soils of Amazonia; the chemical investigation of the water bodies here enable us to draw certain conclusions as to the decomposition processes deriving from the bad weather that hit these soils in the regions of origin. Reports from countries bordering on Amazonia and from the tropics in general confirm the results of the limnological studies.

In addition to the podsolic soils we also find predominating in Amazonia the brownish-yellowish autochtonous soils, frequently with a reddish color (brown clay); these soils are also found along with sediments and this is quite in contrast to the old concept laterites was the principal soil form of the country here (that is to say, in Amazonia).

It seems that the advanced age of the mother rock is quite decisive in podsolization here, along with its petrographic quality, the rather advanced age of the leveled or smooth sections which were formed by them; the historical development of the portion of the countryside here can probably be derived from this.

In connection with the formation of the podsolic soils we run into phytogeographic and geographic problems, dealing with the occurrence and distribution of savannas and clear forests (scrub woodland) in the territory of the Amazon rain forest.

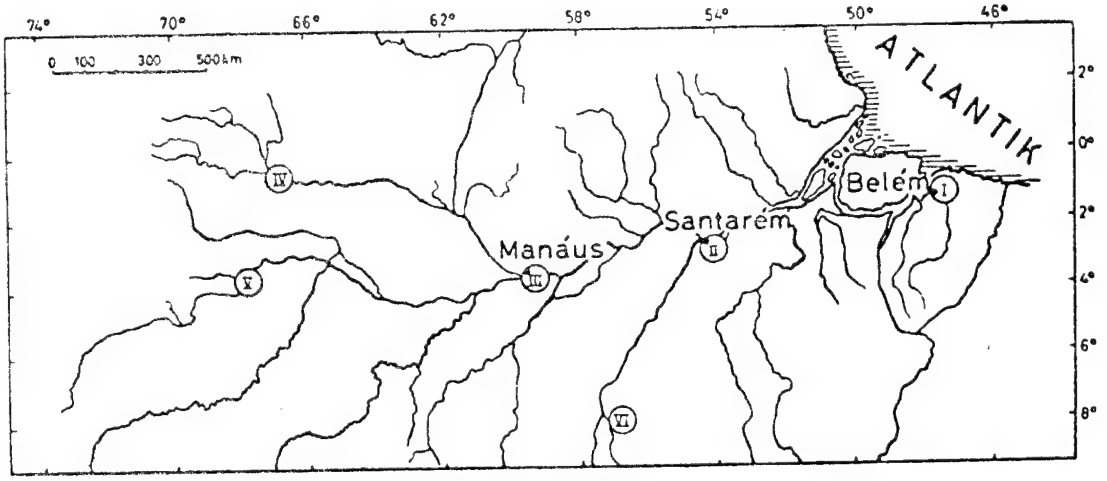
In the settlement area of the pre-Colombian native tribes, which have long since disappeared, we find podsolic or brown podsolic clay soils which have been anthropogenically transformed, similar to the Esch soils in the northwestern part of Europe.

It seems that the podsolic soils of Amazonia are poor in humus.

As far as the relationships between the waters (water bodies) and the soils of Amazonia are concerned, there are a number of indications here on the chemical behavior and the load of suspended matter in the various types

of water; this situation can be understood here against the background of the different soil conditions prevailing in each region of origin. Knowledge of the very close interconnection between water, soil, and plant and animal life enabled our institute to work out a "ecology of labor" which helped us orient our activities and which deals with the study of the waters and their environments, along with the correlations existing between them.

FIGURE APPENDIX



Sketch of Amazon region (with indication of our own edaphological research areas). For the regions marked with a circle, we have samples for the following soil types: I - brown clay, podsol; II - brown clay; III - podsol, brown clay; IV, V, VI - podsol.

Relief of the Pioneer Zone of Espirito Santo and the Disputed Region (Townships of Mantena, Barra de Sao Francisco and Colatina) (pages 243-249)

Manoel Correia de Andrade

(Source: Publication of the Academic Directorate of the School of Philosophy of Pernambuco, University of Recife.)

Introduction

While attending the meeting of the AGB (Association of Brazilian Geographers), which was held in Colatina between 2 and 11 July 1957, I had an opportunity to take a trip to the pioneer region of Espirito Santo and to the area of Mantena -- the area which is disputed between that state and state of Minas Gerais; I took this trip under the direction of Professor Ary Franca from the University of Sao Paulo. We organized a team along with geographer Celeste Mayo, from the National Geographic Council, and Professor Getulio Vargas Barbosa, from the University of Minas Gerais; these men and yours truly constituted the group charged with making geomorphological observations; we were greatly helped here by the French professor Tabuteau, likewise from the University of Minas Gerais.

Our itinerary covered almost 100 km and we had an opportunity to observe a rather well-developed and characteristic relief, featuring a rather accentuated fault scarp in the area of the upper Sao Francisco; here we also frequently found what might possibly be "inselberge," in the area of Aguia Branca, where we appear to have remnants of pediments; here we also detected a much greater acceleration of the erosion processes due to the improper use of the soil by man. I therefore decided to prepare this report on the ground we covered in an attempt to study the relief of this region which is so important to anyone who tries to interpret the influence of climatic variations on the Brazilian relief.

From the physical viewpoint, we observed two areas with their own very special characteristics in the region we covered; these we tried to differentiate in our study here and we want to analyze them separately, giving each one of them the name of the principal urban settlement we found there. The areas will thus be called by the following names:

(a) the area of Mantena, including the region situated to the north of the Pega-Bem mountain range, drained by the Sao Francisco River, a tributary of the Sao Mateus;

(b) area of Aguia Branca, including the drainage basin of the Sao Jose, a tributary of the lagoon of Juparana.

Our observations were made along the highway and we left the highway only at the points of major interest; from there we climbed to the highest points which served as observation posts; but in no case did we move more than 1-2 km away from the highway.

The Area of Mantena

The area of Mantena, situated at 18° 50' South latitude and 41° West longitude, approximately, is characterized by the fact that it is surrounded

by the spurs of the Aimores mountain range which are called various names in the region. The eastern-most spur, for example, reveals elevations of more than 400 m, and is called Pega-Bem mountain range.

The entire region of Mantena is drained by the Sao Francisco River and its tributaries, the Itaunas, Sao Domingos, Vargem Alegre and Turvo, heading toward the Sao Mateus River.

Along the upper Sao Francisco we have a quite visible rise fault which had already been identified by Egler (W.A., 1951); here the elevations drop abruptly from 500 down to 200 m. This river here forms a waterfall which is used for the generation of electric power for a nearby ranch. The direction of the edge of the fault is roughly NE-SW. The existence of the fault has led to a rather intensive resumption of erosion by the tributaries on the right bank of the Sao Francisco River which have young valleys in the shape of a "V" with quite steep slopes inclining approximately 30°. In the scarp we also find many hanging valleys.

These little streams flow between steep, almost overhanging slopes, and about 2 or 3 of them combine at certain points to form suspended and alveolar planes (Figure 1) which are generally used for settlements and for coffee plantation land. These are really the best spots here, once the bottoms of the very narrow valleys no longer permit the construction of homes in the same fashion as along the slopes, where we do not have any river terraces anymore.

We agree with Professor Tabuteau (1957) who says that these hanging planes must be the result of lateral erosion which developed as a result of the fact that a number of the streams and brooks here, at this particular point, ran into depths made up of more resistance rocks; as a result the water was stopped here for some time. Since the water could not dig a deeper bed for itself, these streams carried out a rather intensive erosion on the sides and this speeded up the backward movement of the slopes. After the water had finally cleared these obstacles or steps, the stream became more voluminous and straight-line erosion this time became more intensive; this once again led to the development of the young valleys which met at other points, when they had to overcome another step, forming other alveolar planes.

These planes become larger and larger as we go from East to Northeast, where the elevations are lower and where the relief is less accentuated.

Mantena is a mining town with a population of about 15,000 people; it is partly built on two planes of this type which are quite large and which are drained by the Sao Francisco River; they occupy terraces 2-3 m above the level of the river. The city climbs up along rather steep slopes and we also have some room here for crop cultivation on terraces with a height of 0.50 m; of course these are flooded during the rainy season.

Barra de Sao Francisco, a town with about 4,000 inhabitants, has also been built on a rather narrow terrace about 2-3 m along the Itaunas River; now that the town has filled the available flatland here, the town planners have begun to cut down the hills around the town so that the town

area could be expanded. A rather extensive area less than 1 m above the level of that river and its tributary, the Bambe, is covered with grassland but it is flooded during the rainy season.

In Mantena, we mostly have plagioclase gneisses of the Rio Jucu series (Brajnikov, Boris, 1954) whereas Barra de Sao Francisco is located in a zone of intensive granitization, belonging to the series which takes its name from that town.

In the center of this urban settlement area, located on an island terrace 2-3 m high, where it used to flow in the past, forming meanders, the Itaunas River flows around two hills approximately 30-35 m high; this is a granitic formation or an almost granitic gneiss formation. These are more resistant rocks which escaped river erosion because the Itaunas River was diverted.

The observation of the bed of this river leads to the conclusion that there were variations in the sea level during the Quaternary; this was observed also, elsewhere, by Professor Ruellan (1944) in the region of the Doce River. Thus we see that the river carved its bed into levels lower than the present-day levels; it then accumulated sediments in its flood plain and after that described a number of meanders. The river today is boxed into its own sediments, which it deposited itself.

The Area of Aguia Branca

Between the Pega-Bem mountain range -- which is the watershed for the streams flowing towards the Sao Mateus River and toward the Juparana lagoon -- and the between-stream land, located between the lagoon and the Pancas River, we find an area drained by the Sao Jose River; here we come to the little town of Aguia Branca, the most important settlement in the region. In this area, the erosion force of the Sao Jose forced the 500 meter levels [contour lines] far toward the West, constituting a big basin with elevations gently dipping from 300-100 m, representing the so-called old erosion cycle of Lester King (1957).

In the middle of this leveled surface -- which geologically speaking is a progressive granitization zone -- we find a number of low hills rising to about 200-250 m above the local elevations (Figure 2); these sometimes have vertical slopes and slopes of more than 90°; at the base they form a very well accentuated "knick" [bend] and they can be considered as real "inselberge" [island mountains] (Derruau, Max, 1958). They are very numerous and they are lined up roughly in a NE-SW direction, as in the savanna regions (Baulig, Henri, 1956). I studied them in 1955 and I thought that those at Porto Domingues expressed the existence of granitic batholiths which are so frequent in the state of Espirito Santo.

At the base of these possible "inselberge" we find dejection cones forming; these are the result of the deposit of diffuse surface drainage water tables; this happened when the water encountered decomposed and broken up material on the level surface, coming from the higher portion of these low hills. The rather steep slopes in some points have some rather big grooves or channels and we find xerophyte vegetation developing on the ridges between these grooves. The rather sparse vegetation which we find here certainly supplies the humic acid which give the rainwater the ability to decompose the soluble elements of the rock.

The cones which we can see all along here give us the impression of having been made up entirely of materials transported from the heights on down. The observation, at Mantena, of a rather authentic rock-fan and, in the Upper Sao Francisco mountain range, the observation of a slope with coffee trees planted along the line of major inclination as well as stretches of rocks uncovered by the action of the rain water (Figure 3) leads us to believe that these are rock-fans which, during the current phase of more humid climate, were covered by deposits coming from on high. Coffee cultivation, with coffee plantations along the lines of major inclination, although quite recent, that is to say, less than 40 years old, did revive erosion and caused the rock-fans to be uncovered in a number of points as a result of the migration of the materials deposited on them. Verbal reports tell us that the valley of the Pancas, situated to the southwest of Sao Jose and separated from the latter by low between-stream land -- less than 150 m of local relief -- reveals morphological features similar to those studied.

It is interesting to emphasize the existence, in the basin of the Sao Jose, in the area drained by its tributaries, the Cafe and Aguas Claras streams, to the north of Aguia Branca, remnants of old pediments which today have been quite heavily cut up by river erosion. These pediments have been deposited at the foot of the higher hills; they reveal rather concave slopes which extend over a slightly inclined area, later on turning into a convex slope, forming small saddles on the banks of the brooks we find here. They are very similar to the pediments of the Mascarenhas mountain range which is situated in the townships of Vicencia, Timbauba, and Alianca, in Pernambuco (Andrade, G.O., 1957), partly also because they are located on the same elevations.

We should also call attention to the fact that Lester King (1957) emphasized the existence of a "rolling countryside, splendidly sedimented, whose surface looks dissected by deep valleys of the following cycle (Paraguacu)" in regions near those now under study. Referring to eastern Brazil, the South African expert is more decisive when he says (page 155): "The Brazilian landscape, in the vast region studied, however shows that it developed and is still developing as a result of the regression of the scarps and pedimentation -- a conclusion that agrees quite satisfactorily with the observations made at other points on the globe."

In spite of the rather irregular distribution of the rainfall, the weather today facilitates the development of the Atlantic forest and makes the formation of pediments impossible. This, by the way, is a transition climate between the humid tropical climate and the climate of the savannas. According to Alves de Lima (Miguel, 1955), it is of the type which W. Koppen classifies as Cwb, in other words, it is tropical elevation climate with rainfall in the summer, this being a rather cool season here. The rain gauge index is less than 1,300 mm per year.

Information gathered on the spot led me to assume the existence of two quite differentiated seasons during the year: a dry season, including the winter and spring, producing the "drought" of the rivers, which is generally more accentuated in September; then we have a rainy season, with torrential rains, falling mainly in the summer -- December and January, that is -- and producing big floods in the streams of the region. The water level then rises 1.50-2 m, causing floods which inflict serious damage upon

crops. The farmers, however, have been forewarned and they always build their houses on stilts or piles (Figure 4); this is quite easy due to the abundance of timber and lumber in the region. Egler (W.A., 1951) elsewhere emphasized the influence of this irregular climate on the vegetation; he tells us that the vegetation here is represented by a dry forest, where 30-50% of the species are semi-deciduous. This is therefore a zone with a climate overlap between the humid shoreline climate and that of the savannas of the interior. It is quite obvious that, during the climatic variations of the Quaternary, although they might have been very minor at that, this climate must have revealed periods of lesser humidity or even more pronounced dry seasons; this facilitated the development of the pediments which today are to a great extent cut up by river erosion.

The Problem of Human Erosion

Another aspect which must not be overlooked by the geomorphology student is the aspect represented by the action of man which has contributed to the intensification of erosion processes. Tricart and Derruau (1956), two French instructors, have called the attention of researchers to the problem of soil erosion which is intensified here by the action of man. From this viewpoint, what we can see in the area of Colatina -- Barra de Sao Francisco -- Mantena is simply alarming. Porto Domingues (1955) was so impressed by this that he proposed that slopes with an inclination of more than 30° not be cultivated and that they be used for natural vegetation.

The greediness of the landowners, who are prevented from growing coffee on the flood plains because of the process of temperature inversion -- which causes a concentration of cold air along the lower portions -- has made them grow coffee along the slopes, even at those points where these slopes are extremely steep, up to the foot of these hills.

This crop is grown by means of some rather routine processes; the crop layout does not follow the contour lines and the disappearance of the natural vegetation causes the water, coming down from the hills during the heavy rainstorms, to continue to flow between the rows of coffee trees, carrying the entire soil from the slopes down into the valley. There are quite high points, as those in Figure 4, where we find stretches of rock exposed between the rows of coffee trees.

The rapid impoverishment of the soil causes the coffee plantation area to be abandoned and the plantation area then keeps moving toward North-Northwest, where the forest reserves and the virgin territories are being exhausted. But coffee is now being replaced by animal husbandry and this only serves to continue the intensification of the work of erosion. This intensification of the erosion results from the fact that the cattle land occupies the slopes and that each enclosure accommodates more animals than it really should. The intensively grazed cattle land then dies and big ravines are formed on the slopes. After the death of the plant vegetation here, the soil is carried away on a large scale by the rain water whenever we have a big downpour and after some time these rocks in the subsoil are exposed. I therefore think that the relief of the region studied here reflects the variations of the climate during the Quaternary which are quite neatly indicated by the transition climate that is still found prevailing here today. I also think that the acceleration of the erosion, produced by

the improper use of the soil, combined with the use of rather rough farming methods, which only speed this process up, should require the governments of these two states to take energetic steps so as to preserve a patrimony which must be used by future generations. We must do some very effective long-range planning here in order to prevent the formation of deserts in areas that are still fertile and that can still be efficiently exploited.

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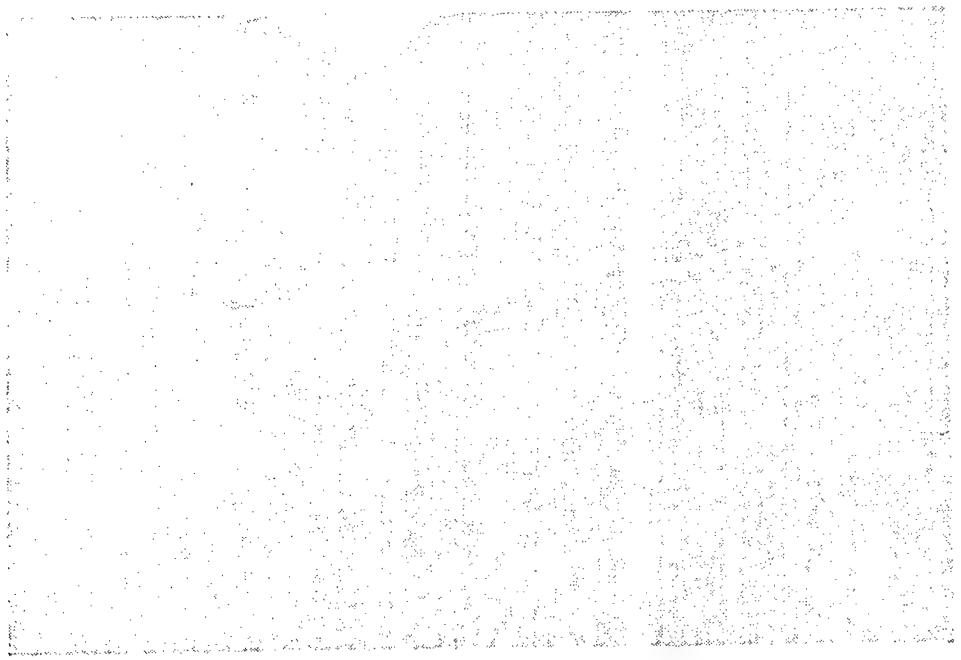


Figure 1. Suspended alveolar plane along the Upper Sao Francisco. On the right we see the coffee plantation installation. The coffee trees climb up the rather steep slope and thus contribute to the acceleration of erosion. Author's photo.

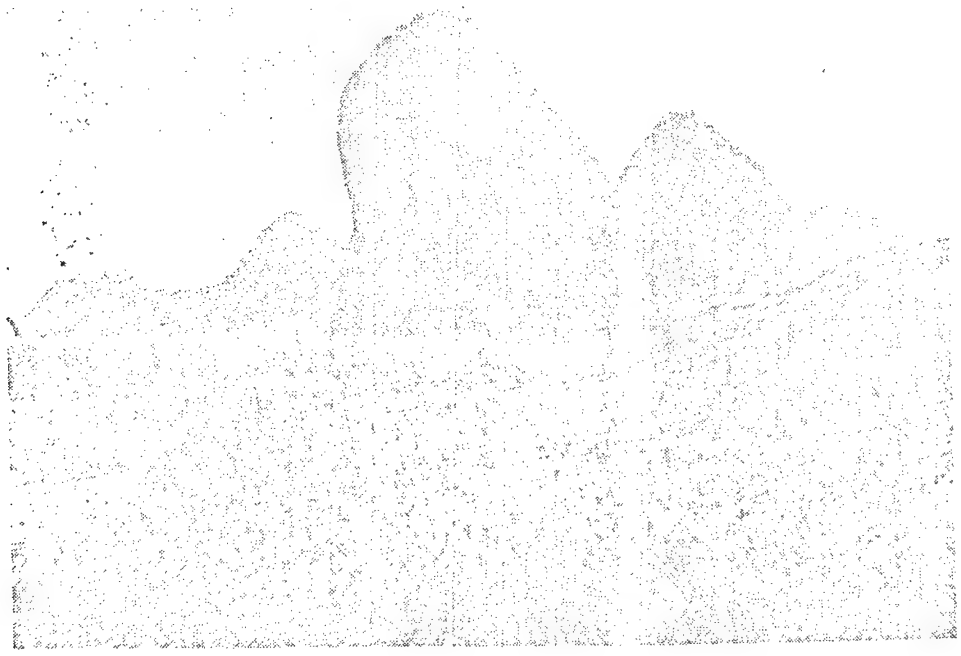


Figure 2. Very steep hills in the region of Aguia Brancs. We can see that they are located on a leveled surface. Author's photo.

Figure 3. Coffee cultivation area, with coffee trees lined up along line of major inclination along a rather steep slope; this leads to soil shifting. On the right we notice the exposed rock and in the center, in a roughly triangular area, reveals some exposed soil where no more coffee can be grown. Author's photo.

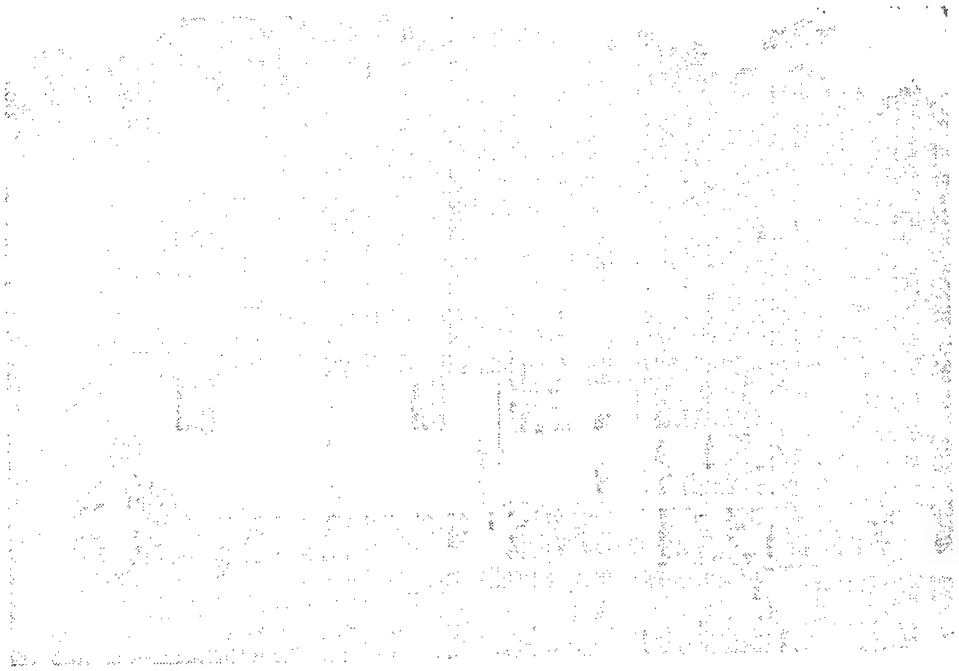


Figure 4. Sharecropper's hut, built on a plantation in the region of Aguia Branca. In the foreground we have the coffee-drying area and in the back, on a little hill, further up, we find some exposed rocks. Author's photo.

The Federal District and the Geo-Economic Regions (pages 281-284)

Maria Magdalena Vieira Pinto

I. Introduction

We must point out, from the very beginning, that this report is the result of field observations and research conducted during two study trips whose purpose it was to collect material for a work on the geographic aspects of the supply situation of Brasilia. Of course, we will also make use of the knowledge which we have available on the Center-West region.

This information although should not be considered definitive. In this report I want to present only some of the most obvious facts on the zones surrounding the Federal District; these are the points which, because of the importance of their subject matter, should be studied and investigated in greater detail; the upshot of all this should be set of very profound conclusions, in the end.

II. Definition of the Geo-Economic Region

(a) Regional Division and Geo-Economic Division

The term "geo-economic region" is applied to a geographic region whose population, for the most part, lives or works in connection with one major economic activity and which characterizes the economy of the region. This activity of course need not be exclusively predominant in this geographic region but it should nevertheless be the most important activity.

A geo-economic region is generally covered by a "natural region," although its boundaries and its area do not generally depend upon the "regional division" boundaries.

For example: the major region of Center-West is one of the "geographic regions" into which Brazil happens to be subdivided. Within the Center-West Region we have new subregions and zones which we are trying to establish along major lines of differentiation with respect to the physiographic nature of the territory.

In general, the facts of physical geography are the basic factors in the establishment of a regional division. In the case of the Center-West region, for example, we consider the two primary elements of that region: the vegetation (the woodland savannas) and the relief (sedimentary strata).

Within the subregions and the physiographic zones (thus laid out for administrative purposes) we can distinguish areas where a particular economic activity might predominate. We know that there are three basic economic activities in the Center-West region: animal husbandry, agriculture, and the extraction industry (vegetal and mineral). As we study the areas where these activities are most pronounced, within the region, we can characterize certain geo-economic regions within the major region of Center-West.

But we must nevertheless remember the following:

(1) The influence of the physical environment upon the economic activity of the particular group of people here is very important;
(2) The material conditions of the population (availability of transportation and communications, capital, skilled manpower, etc) are bound to lead to very great differences, from one region to the next, which, although neighboring, are going to develop into zones with different economies, different productivity or specialization.

Thus the Center-West region reveals five major geo-economic regions although their importance differs because of the regions mentioned above.

In summary we must point out that the term "regional division" refers to the area characterized by a group of natural phenomena, related to each other whereas the term "geo-economic division" refers to the geographic area where a specific population activity predominates.

We note that these geo-economic zones can also be transformed if the economic situation is not fixed and rigid.

(b) The Federal District and the Geo-Economic Zones

The Federal District, as such, does not constitute a geo-economic zone but it does represent an excellent consumer market which might very well be used by the surrounding supplier regions.

As a matter of fact, the region where the Federal District is located is not at all developed and has a rather low productivity index. The present-day rural settlements in the Federal District do not even meet 40% of the requirements of the consumer sources. In order to meet local consumption requirements, we must import both goods and services from rather distant producer sources (Sao Paulo, Belo Horizonte, Rio de Janeiro) and this of course creates supply and price problems.

It is therefore desirable and perhaps even indispensable to make a coordinated effort here in the realization of a planning program aimed at making use of the nearest producer areas; some of them are excellent producer zones whereas others could be improved very shortly and thus supply the market of Brasilia. Both of these types of regions could definitely become supplier regions for the Federal District as soon as a minimum of requirements has been met, such as transportation facilities, technical resources, and capital.

III. Main Characteristics of These Zones

The Federal District, as we said before, is near geo-economic zones that are already enough developed and that are quite busy; they constitute a source of supply for Brasilia. Moreover, the Federal District is close to other zones which, because of their potential wealth, could be transformed into new geo-economic zones of the Federal District in a not too distant future.

(a) Existing Geo-Economic Zones

We use the word "existing" here because the Federal District now uses them for its supply shipments. They are the following:

(1) The Mato Grosso of Goias -- which is mainly an agricultural zone, the most important farming zone in the Center-West region; here we mostly find crop land and cereal crops; it also contains some of the more important cities of the Center-West region, such as Goiania and Anapolis, where we have transportation, manpower, and capital facilities available. In this zone we can distinguish an older area where animal husbandry followed agriculture (Ceres, Carmo do Rio Verde) and a newer area, a forest area, where we run into the pioneer frontier.

(2) The Zone of Ipameri --some townships in this zone are now accommodating regular cattle herds and they have refrigeration warehouses in operation (Catalao); they also have a number of slaughter houses which regularly supply meat for the population of Brasilia.

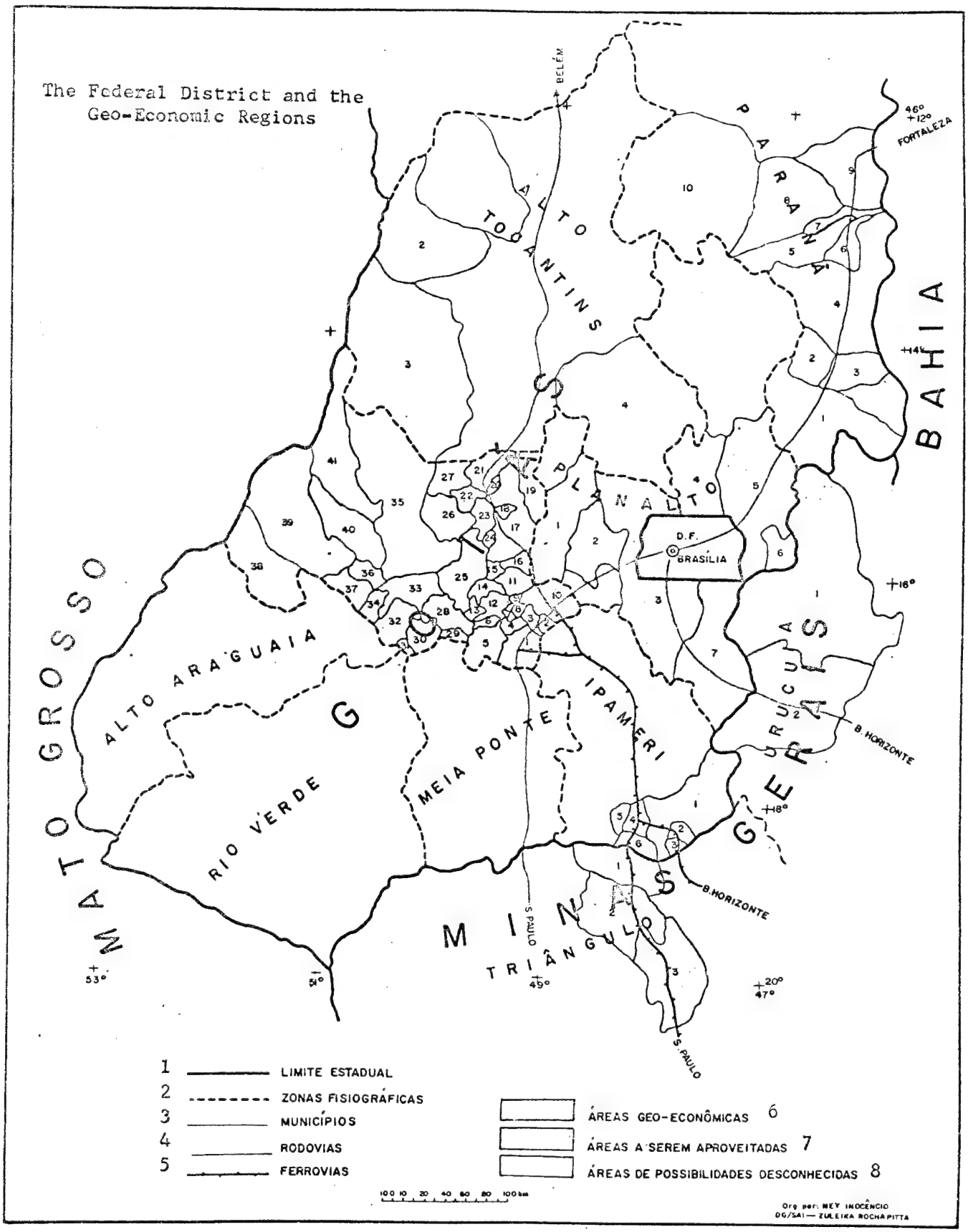
(3) Zone of the Plateau -- Here animal husbandry and mining activities prevail (Formosa, Luziania).

(4) Triangle Zone -- Including the region left between the Grande and Parnaiba rivers, along the boundary with Sao Paulo, Mato Grosso and Goias. This is one of the most important zones of pure-bred cattle raising ranches in the country (Uberaba, Uberlandia); this is also an excellent milk cattle area (Araguari). Agriculture is quite well developed here especially in areas where we note strips of purple earth.

(5) Urucuia -- The economy of this zone is based on animal husbandry in agriculture, especially the raising of cattle with the help of the natural pastures in the higher, steep-sided tablelands (Paracatu, Unai).

(b) Areas That Can Be Used [Improved]

The following townships can be improved and used, beyond a doubt, as a result of a study of areas in addition to the zones mentioned above:


The Federal District and the
Geo-Economic Regions
BELÉM
FORTALEZA
BAHIA
TOCANTINS
ALTO
PARANÁ
PLANALTO
D.F.
BRASÍLIA
GOIÁS
B. HORIZONTE
MATO GROSSO
ALTO ARAGUAIA
RIO VERDE
MEIA PONTE
IPAMERI
MINAS GERAIS
TRIÂNGULO
S. PAULO
46°
+12°
+14°
+18°
+20°
53°
50°
49°
47°
1 LIMITE ESTADUAL
2 ZONAS FISIOGRÁFICAS
3 MUNICÍPIOS
4 RODOVIAS
5 FERROVIAS
ÁREAS GEO-ECONÔMICAS 6
ÁREAS A SEREM APROVEITADAS 7
ÁREAS DE POSSIBILIDADES DESCONHECIDAS 8
100 10 20 40 60 80 100 km
Org por: NEY INOCÊNCIO
DG/SAI — ZULEIKA ROCHA PITTA

Legend of map on preceding page: 1 - state boundary; 2 - physiographic zones; 3 - townships; 4 - highways; 5 - railroads; 6 - geo-economic areas; 7 - areas to be improved; 8 - areas with unknown possibilities.

(1) Planaltina and Niquelandia, in the basin of the Maranhao River; this is a zone of considerable animal herds and forest areas which could be used for agriculture.

(2) Sitio de Abadia, Iaciara, Posse, Sao Domingos, Galheiros, Monte Alegre de Goias, Arraias and Taguatinga, in the basin of the Parana River; this is a traditional animal husbandry area and the soil is very fertile; here we still have many forest areas and the area of course is opened up by the highway from Brasilia to Fortaleza.

(3) Araguacu, Sao Miguel do Araguaia and Caixas, located in the basin of the Araguaia River; these townships of course have the best natural pasturages along the banks of that river and some of its tributaries; this certainly makes animal husbandry look very profitable and promising here; in addition these townships also have great forest areas, similar to those of Mato Grosso de Goias and here we have tremendous possibilities for cereal crop cultivation; the Belem-Brasilia highway, which runs across the Tocantins -- Araguaia divide, could of course be used in shipping the production of these townships.

(4) Corumba de Goias and Pirenopolis; these townships of course do not have as much fertile land but they are nevertheless in a good position because of their proximity to the Federal District and because of the transportation facilities available here.

(5) -- All of the other townships of Mato Grosso de Goias that are shown on the map; as we know, this zone reveals special soil and weather conditions, combined with the factor of the proximity of Brasilia and the satellite cities.

(c) Analysis of the Map

The map shows a strip of the state of Goias and Minas Gerais where we have townships which, in accordance with the legends, represent either geo-economic zones that are already supplying the market of Brasilia or that are doing so indirectly; they are particularly worthy of our interest here because of the area in which they are developing.

The empty spaces on the map refer to the area whose importance has not been deemed sufficient to cover in the studies connected with our two trips.

It was therefore considered advisable not to include them in the zones of supply for the Federal District, except in an indirect fashion.

We might say that the areas shown on the map will develop a kind of balance amongst themselves, perhaps constituting one single, great supply region for the Federal District, because of the favorable natural conditions and the transportation network which we have there -- something that also

helps the more distant areas, of course. This is true of Araguaia and Parana which will be on an equal footing with other areas actively participating in the supply of the Federal District, such as for example, Mato Grosso de Goias and Paranaiba.

Breakdown of Townships by Physiographic Zones

I - Goiás

a) Alto Tocantins

1 - Araguaçu
2 - São Miguel do Araguaia
3 - Corixás
4 - Niquelândia

b) Mato Grosso de Goiás

1 - Goiânia
2 - Goianópolis
3 - Nerópolis
4 - Goianira
5 - Trindade
6 - Caturai
7 - Brasabantes
8 - Nova Veneza
9 - Damolândia
10 - Anápolis
11 - Petrolina de Goiás
12 - Inhumas
13 - Araçu
14 - Itauçu
15 - Brasilândia
16 - São Francisco de Goiás
17 - Jaraguá
18 - Rianópolis
19 - Goianésia
20 - Rialma
21 - Ceres
22 - Carmo do Rio Verde
23 - Uruana
24 - Itaguaru
25 - Itaborai
26 - Itaporanga
27 - Rubiataba
28 - Anicuns
29 - Nazário
30 - Turvânia
31 - Firminópolis
32 - São Luis de Montes Belos
33 - Moçâmedes
34 - Córrego do Ouro
35 - Goiás
36 - Nôvo Brasil
37 - Fazenda Nova
38 - Diorama
39 - Juçara
40 - Itapirapuã
41 - Aruanã

c) Planalto

1 - Pirenópolis
2 - Corumbá de Goiás
3 - Luziânia
4 - Planaltina
5 - Formosa
6 - Cabeceiras
7 - Cristalina

d) Paranã

1 - Sitio da Abadia
2 - Jacira
3 - Posse
4 - São Domingos
5 - Monte Alegre de Goiás
6 - Galheiros
7 - Campos Belos
8 - Arraias
9 - Taguatinga
10 - Paranã

e) Ipameri

1 - Catalão
2 - Ouvidor
3 - Três Ranchos
4 - Goiandira
5 - Nova Aurora
6 - Cumari
7 - Anhanguera

II - Minas Gerais

a) Urucuia

1 - Unai

4 - Paracatu

b) Triângulo
1 - Araguari
2 - Uberlândia
3 - Uberaba

The Brazilian Shoreline: Types of Coasts
(pages 315-319)

Alfredo J.P. Domingues
Geographer of the CNG

(Summary of lectures delivered during the "Geographic Information Course," given in July 1960.)

The contours or outline of the literal are the features that give the continents their characteristic appearance today, a shoreline, in other words, which we are familiar with today because of our topographic maps.

However, we must remember that the shorelines today, in reality, correspond to one of the hypsometric lines of the region. This line is very important and investigators and reseachers refer to it as a basic line to which we assign a conventional value or an elevation above sea level of 0 m.

This line looks like a rather stable line, at least as we look at it on the map; but if we take a closer look, we must say that the literal (the area of contact between the oceans and the continents) is in reality a strip or band. Let us therefore discard here the basic concept which considers the literal as a line of water and let us consider it as a zone which inclues the coast, the beach, and the submarine terrace, which generally, preceeds the continental shelf. Finally we must also include here the submarine terraces.

Although shorelines always seem to have attracted the attention of geographers -- only much later than other features -- they have now become the object of a series of geomorphological studies which have brought out a number of types of shorelines.

The shore strip or coastal strip is not only the result of the interaction between the sea and the land but it is the consequence of the structure

of the hinterland. Due to this, the literal has become a chapter in geomorphology which deals with a mode of the relief.

We must study the literal as a function of their nearby relief and not as a function of an extensive nomenclature where all the names of the islands, capes, peninsulas, and bays would be reported -- something that was done during the studies prepared on trips made during the 15th, 16th, and 17th centuries.

Along with the oscillations in the ocean areas, which show that the coast line is not fixed, man today has recognized a series of signals which indicate a variation of the ocean level at various points on the surface of the earth. We thus encounter rocks which contain remnants and imprints [footprints] of marine animals at an elevation of thousands of meters whereas at certain other points, we have continental rocks that suddenly turn up below the level of the sea.

Thus we see that, although the present sea level might come pretty close to a reference point, from which we mark our elevations, we must nevertheless keep in mind that it oscillated as time went on.

To get a better understanding, we need merely look at the regions covered by a glacial or ice cap, such as Greenland and the Antarctic, where the thickness even exceeds 1,000 m. If all of this ice were to melt as a result of a sudden change in the weather, then the volume of the ocean would increase and the level of the ocean would top the current level by 30 m. Thus all of the lowland areas would be flooded and mankind would face some extremely serious problems.

As we study the history of the earth, during the Quarternary, for instance, we note that the ice caps were considerably larger and that they covered vast areas of Europe and North America. As a result, we find the oceans at an elevation that was about 90 m lower than the current figure. During that period we had vast strips of land which increased the area of all of the maritime regions and which was subjected to the spread of the ice cap.

Today, archeological studies reveal the existence of civilization which lived 3,000 ago and whose remnants can be found at points below the current sea level, as in the case of the Persian Gulf, where remnants and vestiges of the ancient Sumerians have been found; these people had to move to higher points.

These changes in the sea level -- regardless of whether they are due to the melting or accumulation of ice on the continents or whether they are a consequence of the accumulation of sediments -- are called "eustatic oscillations."

Generally, these oscillations are found associated with slow movements in the earth's crust due to isostatic readjustments."

In addition to these movements, we have the orogenic dislocations which cause considerable elevations to rise in certain places whereas other areas drop.

In summary we can say that the outline of all of the coasts was initiated by relative movements between the land and the sea. The raising of a certain region or its submersion brought about different types of landscapes.

The submersion of a region of hills and valleys led to a coastline that is heavily cut by bays, broad estuaries, gulfs, fjords, and narrows, separated by promontories, peninsulas, and islands.

The emersion coasts, on the other hand, look like protrusions, with broad waves in their basic outlines, etc.

But we must identify other types of coast lines, such as those that are due to volcanic activities, due to faults, due to the action of the ice, due to the growth of cliffs, etc.

These coast lines are rapidly modified by the action of the agents of shore erosion and by sedimentation; as a result we have a large variety of shore line shapes and coastal landscapes.

As a result of the continuous action of the waves we can observe the demolition of rocks that looked almost indestructible. Their fragments are gradually pulverized and the materials may constitute deposits at the base of the elevations. These products, added to those brought in by the rivers, contribute to the increase of the continental zone.

Initially we find sandy belts forming here and then, as the lagoons are gradually closed up, the entire marine strip becomes wider.

The action of the waves is very important along the development of the literal. It results from a wave-like movement which brings about a current and which, at certain times, when strengthened by very strong winds, can have a very intense effect upon the shoreline, causing the formation of undertow grottoes, etc. In our study of the literal, we are primarily interested in studying the fragment-carrying currents. As we study a section of the beach, we can see that the waves very rarely touch the literal perpendicularly; the withdrawal of the water always forms an angle of refraction which is essentially the same as the angle of incidence. As we carefully examine the fragments, we note that many of them follow this back and forth movement of the waves and are moved along the literal. Of course, this displacement is more considerable as the waves become bigger and as they thus shape up sandy belts (wooded sand bars or spits).

Another important current in shaping the literal is represented by the tides which can contribute -- in certain estuaries covered by mangroves and lagoon depressions -- to the deposit of particles and to their cementing.

To give the reader an idea of the tides in Brazil, we might look at the following:

Paranagua	1.89	maximum semi-amplitude
Carbo Frio	1.02	" "
Salvador	1.59	" "
Natal	1.91	" "
Fortaleza	2.08	" "
Amarracao	2.18	" "
Itaqui	4.08	" "

Along the southern coast, the amplitude is quite small and does not even amount to 1 m in Rio Grande do Sul.

Along the north coast, the values are somewhat greater and they exceed 8 m at Itaqui.

In some of the colder places, the coastal strip is subjected to the action of the ice but we are not interested in that here.

In the cliff and steep rock areas, which are worked over by the waves, we can observe the separation of a large quantity of materials constituting a deposit which is gradually being worn down by the waves.

Chemical processes are very important here because they are responsible for the formation of deposits which lead to hardening due to the cementing of the sand grains.

Animal life here is quite diverse. Some of them build up cliffs (coral, calcareous seaweeds) which constitute obstacles to the action of the waves.

Others prefer the rocks, such as in the case of the sea urchins and certain molluscs. Some of them dig into the sand, such as they sea cucumbers.

As a result of the action along the shoreline, we find relief forms represented by cliffs and beaches.

The former correspond to the forms of erosion whereas the latter would be the result of accumulation.

The cliffs here are not covered by vegetation, they have rather steep slopes (varying from 15° to vertical and they can form grottoes). These cliffs are almost always preceded by a rocky platform which shows how the rocks have been attacked here.

The beach as such is an accumulation of miscellaneous material on the shoreline; we can find beaches made up of pebbles, sand, and silt.

The finest materials generally are due to the chemical action of the

waves upon the coarser particles.

If the action of the waves produces a displacement of the material, we may have a formation of shoreline belts or strips which would then straighten out the shoreline.

Classification of Shorelines

To simplify the situation, we would like to adopt a litoral classificiation here based on the "initial" or primary types which, along with the development of the area, then turn into the subsequent forms.

1. Coastline of "estuaries" -- This corresponds to the line of the river systems that are invaded by the sea; these are easily recognized because, on the bathymetric maps we can find the outline of the old hydrographic network, represented here and there by covered meanders; we have some good examples of this type of shoreline in Brazil.

2. Coastline with "fjords" -- This coastline owes its present-day appearance to a submersion and the fjords correspond to the glacial valleys that were invaded by the sea (Norway).

3. Glacial plain litoral -- This would be an emerging shoreline, today, as in the case of Sweden; it corresponds to the plains shaped by glacial erosion.

4. Non-glacial plain litoral -- Here we have the others which correspond to the extensive alluvial plain [flood plain] shorelines which are covered by mangroves or beaches and dunes, etc.

5. Litoral with structural influence as such -- This is due to the faults or fractures that occurred here and this group includes shorelines with volcanic islands or shorelines subject to dikes.

The litoral of Brazil represents almost no re-entering angles or curves, as we can tell from a look at the map of Brazil; only Africa has a more straight-line outline. It suffices to say that the major openings in our coastline are represented by the following:

Amazonian Gulf	85,500 sq km
Gulf of Maranha	11,850 " "
Bay of All Saints	1,052 " "
Bay of Paranagua	677 " "
Bay of Guanabara	412 " "
Bay of Sao Francisco	108 " "
Patos Lagoon	9,985 " "

As far as the islands are concerned, we can arrange them in two categories: oeanic and continental.

The "oceanic" islands are represented for instance by the islands of

Trinidad and Fernando de Noronha and these of course are volcanic islands.

As far as the "continental" islands are concerned we have quite a variety here. Some of them are very closely related to the neighboring relief, such as the island of Sao Sebastiao and the island of Santa Catarina.

Others, however, correspond to the "dependent" islands, such as the deltaic islands, in the archipelago of Marajo and Parnaiba. These are generally very low islands; they are sandy or swampy and they are usually reshaped by river erosion or by other acts.

One very special type here is the type of the "set-in marginal island." These are islands that are isolated from the continents by channels. These islands reveal a very irregular topography. Their geological make-up, their relief, and their hydrography are similar to the nearby continental areas. As examples we might mention the following: Maraca, Sao Luis, Itamaraca, Tinhare, Boituba, Sao Francisco, etc.

According to Professor Backheuser, we ought to consider another category of islands represented by those that are due to tectonic accidents. Among them we might consider the islands of Sao Vicente and those on the outside of the Bay of Guanabara.

Another category here is the category of "mixed origin," such as the island of Marajo.

Finally we might consider the category of "independent islands which might be subdivided into "exterior litoral" and "intermediary" islands.

We can thus consider this block of the Mar mountain range, which runs parallel to the coastline, to be due to the presence of fractures which isolated it in the form of blocks swinging back and forth into the interior. Here we might mention the island of Santa Catarina, the islands of Quermedes, the Alcatrazes islands, the Sao Sebastiao, and the Grande island, etc.

To understand the development of the litoral, we must study a geological and a tectonic map. We immediately notice, in the genesis of our literal, phenomena of a "tectonic order," to the detriment of the external dynamic agents which impress us at first.

Of course, the outline of the continent here serves as a field of action for these movements and for the "eustatic movements" as such.

As we examine the shoreline, we notice that we are looking at a massively accentuated oceanic line, where we do not have any deep gulfs and where not even the peninsulas stick out too much, certainly not as much as they do in other parts of the world. This is due to the fact that the Brazilian coast, generally, is of the "concordant type of negative displacement."

Since it is granitic in long sections, we would, if it were discordance, have a succession of estuaries, fjords, deep profile sections, all of which would generally depend upon the structure of the continent.

The great oscillations in the ocean outlines remind us here of the old [ancient] Tertiary and also of the Cretaceous, a time when our shoreline was quite different from what it is today.

Classification of Brazilian Shoreline

On the basis of the geotectonic elements, Raja Gabaglia in 1916 presented the following section breakdown:

1. Mangrove coast -- from Cape Orange to the north;
2. Estuary coast -- along the Amazonian section;
3. Mixed coast -- from Point Tijoca to Parnaiba;
4. Dune coast -- up to Cape Santo Antonio;
5. Concordant coast -- up the sand bar of Ararangua;
6. Sandy coast -- from Ararangua to Xui.

The basic criterion adopted in this classification was that of the nature of the coastline and tectonics was used here only where it was absolutely necessary.

On the basis of the geological criterion, we might divide it the way Professor Delgado de Carvalho did:

(A) Quaternary coast from the northern corner up to Maranhao. Terrigenous coast.
(B) Tertiary coast with some granitic structures, representing barriers, dunes, and cliffs. Emersion coast up to Cape Frio.
(C) Quaternary coast along the south, emersion coast.

Aroldo de Azevedo divided the coastline into three sections:

(A) The northern litoral, characterized by a depression, full of mangroves and swamps, made up of black and compact mud, generally quite inhospitable and provided with a very characteristic vegetation of its own, such as the red mangrove or "ratimbo." Here we have a series of coastal lagoons. This includes the Amazonian Gulf, a region which is constantly changing. This section extends all the way down to Cape Sao Roque, in Rio Grande do Norte;

(B) The eastern litoral, which extends between Cape Sao Roque and Cape Sao Tome:
1. The section leading up to the Bay of All Saints (50-60 m sand bars and coastal lagoons with cliffs);
2. A shorter section, which is lower and which is cut off toward the south;
(C) The southern coast with a quite different appearance.

In the first section or stretch, the River Depression, with lagoons, spits and bays, we have many inlets and bays surrounded by high mountains whose sides drop straight down into the ocean.

Further to the South, we have the second stretch, started by the Bay of Peranangua; this is followed to the South by a series of beaches supported by crystalline elevations which rise in the form of islands in the midst of the alluvial [flood] plain. Its final portion is characterized by the appearance of huge spits; here the crystalline component disappears from the surroundings of the sea.

Hydrographic Basins
(No 186, pp 407-430) Lt-Col Asdrubal Esteves

(Source: A Defesa Nacional (National Defense), Vol L, Rio de Janeiro, GB, December 1963, No 592.)

IV. The Basin of Paraiba do Sul

1. Physiographic factors

1.1. Description of area (Figure 1)

1.1.1. Size

The Basin of the Paraiba do Sul [Southern Paraiba River], one of the largest independent basins making up the entire eastern basin, covers the area irrigated by the river of that name and its tributaries; this area has been calculated at 56,500 sq km, all of which are located on Brazilian territory; it accounts for roughly 0.7% of the total area of Brazil. It extends over the states of Sao Paulo (13,500 sq km), Rio de Janeiro (22,600 sq km), and Minas Gerais (20,900 sq km).

1.1.2. Shape

The area is rather long drawn out, extending from East to West, with a ratio of about 3:1 between its maximum length and its maximum width.

1.1.3. Location and Boundaries

It occupies the eastern part of the state of Sao Paulo and, covering the area which extends to the North of the Orgaos mountain range, along almost the entire state of Rio de Janeiro, it penetrates in its middle portion into the state of Minas Gerais, through the basins of its tributaries which come down from the southern slope of the Mantiqueira mountain range.

The the North it is bordered by the following mountain ranges: Mantiqueira, Caparao and Santo Eduardo; these mountain ranges initially

separate it from the basin of the Parana which is represented here through the basins of its tributaries, the Tiete and the Grande, and, from the northeastern spurs [foothills] of the first-named mountain range, through the independent basins of the Doce and the Itabapoana, both of them making up the eastern basin.

To the East we have the Atlantic shoreline.

The Orgaos mountain range and the Sao Paulo section of the Mar mountain range border on it to the South, separating it from the small independent basin of the coastline of the state of Rio de Janeiro and the eastern part of the state of Sao Paulo.

To the West the area is bordered by the rather low elevations in the vicinity of Moji das Cruzes which separate it from the head waters of the Tiete, a tributary of the Parana.

1.2. Geology

In the area of the basin we find predominating the ancient land of the Pre-Cambrian, where the Archean appears to be dominating the situation rather extensively since the occurrences of the Algonquian are rather modest and are located along the boundaries of the basin, corresponding, in Minas Gerais, to the head waters of its tributary, the Paraibuna. (Note: The existence of two rivers by the name of Paraibuna forces us to make a distinction between them; first of all we have the original stream which is located in the state of Sao Paulo and then we have the tributary which is located in Minar Gerais.)

The Tertiary soil is found in two sections accompanying the channel of the lead river here and a narrow strip along the coast. The largest of these areas is the one extending from the confluence of the Paraitinga with the Paraibuna (the source river) all the way to the region of Cachoeira Paulista; the other one [the other area] extends from Resende to Volta Redonda. The recent terrain in the shore depression is made up of a narrow strip of Tertiary evolving into the recent Quaternary (Holocene), corresponding to the delta of the principal river.

It addition to these occurrences we also find the massif of Itatiaia, in the mountain range of Mantiqueira, consisting of alkaline rocks, presumably eruptive, with a highly disputed age. According to some people the age would be Proterozoic whereas according to others it would be Mesozoic (Rhetic).

The soils in the basin are very fertile but they are therefore easily exhausted; they reveal the typical characteristics of original Archean decomposition terrain. The fertility is more lasting only in a few valleys; on the slopes in the higher reaches, and in the valley of the main river here, the careless cultivation procedures involved in the coffee plantations practically exhausted the soil, reducing the area to relatively poor pastureland today.

1.3. Orography (Figure 2)

The relief conditions differ in accordance with the regions which involve the three parts into which the principal river is subdivided. Let us use this subdivision in studying the orography.

First we have the region of the Upper Paraiba -- between the sources of its principal source rivers: the Paraitinga and the Paraibuna and their confluence; this is a predominantly mountainous region with rivers generally flowing from east to west, in valleys opened up between the foothills of the mountain ranges of Bocaina and Quebra-Cangalha, to the North, and the Sao Paulo section of the Mar mountain range, to the South. The Bocaina mountain range reveals average elevations in excess of 1,200 m (with some mountains topping 2,000 m) and the Quebra-Cangalha mountain range reveals average elevations on the order of 1,000 me. The Mar mountain range reveals elevations of 1,600 m in the region of the boundary between the states of Rio de Janeiro and Sao Paulo and the elevations decrease as we go toward the West, down to an elevation of 800 m at the end of this area.

The region of the Middle Paraiba -- between the confluence of the Paraitinga and the Paraibuna (source river) and the region of Itaocara is the region which includes this stretch of countryside; it is called the valley of the Paraiba and it extends from West to East, in other words, opposite to the direction of the earlier section or stretch; it reveals three lateral strips:

-- the flood plain, a depression with an almost level configuration which accompanies the trough of the principal river with a variable width that is sometimes quite considerable;

-- the crystalline and Tertiary hills at the bottom of the valley; these are low elevations which immediately follow the flood plain and which sometimes penetrate into it;

-- and finally we have the slopes and the peaks of the crystalline mountains; here we find the Paraiba valley bordered to the North by the Mantiqueira mountain range which runs parallel to the river from the region of Sao Jose dos Campos all the way to Volta Redonda and, from here, it turns away to the basins of the Paraibuna (tributary) River and the Pomba River; to the South it is bordered by the previously mentioned Quebra-Cangalha and Bocaina mountain ranges and by the Orgaos mountain range.

The elevations in the Mantiqueira mountain range are: 1,700 m in Campos do Jordao (SP); 2,787 m at the summit of Agulhas Negras (MG-RJ); 1,400 meters at Bom Jardim de Minas, and 1,000 m to the North of Santos Dumont (MG).

The Quebra-Cangalha and Bocaina mountain ranges, which constitute the dividing line between the Upper and the Middle Paraiba, reveal elevation figures which we gave earlier; the Orgaos mountain range reveals elevations above 2,200 m between Petropolis and Teresopolis and 1,200 m to the East of Nova Friburgo.

Along the southern boundary of the basin, between the region of the divide between the states of RJ-SP -- where we come to the Bocaina mountain range and the Sao Paulo stretch of the Mar mountain range and the region of Miguel Pereira, where the Orgaos mountain range begins -- we come to a relatively low region where altitudes do not exceed 800 meters; here we find the railroad line and the highway; this region is also used for the transfer of water [waterworks] used for the generation of electric energy, as we shall see later on.

Now we come to the region of the Lower Paraiba -- from Itaocara all the way to the ocean; this region starts from Itaocara and here the flood plain increasingly assumes the appearance of a coastal plain. Some of the lower mountain ranges here still are rather close to the principal river, as in the case of the Santo Eduardo mountain range, the dividing line between the basins of the southern Paraiba and the Itabapoana; here the elevations are around 1,000 m; next we have the Rio Preto mountain range to the far Northeast of the Orgaos mountain range which, to the South of Sao Fidelis, reveals average elevations on the order of 1,000 m and mountain peaks up to as much as 1,800 m. The head waters of the basin of the principal tributary, which we have in this particular section, that is to say, the Muriae River, are located in the foothills of the Caparao mountain range, at elevations in excess of 1,200 m, along the boundary with the basin of the Doce River.

1.4. Hydrography

1.4.1. Water Courses

(a) The Principal River:

The Paraiba do Sul [southern Paraiba] is made up of the Paraitinga and the Paraibuna rivers which flow together in the region of Paraibuna (SP), about 30 km to the South of Cacapava and at an elevation of about 700 meters. The two original source streams here have their origin in the vicinity of the boundary between SP and RJ, respectively, in the Bocaina mountain range and in the Mar mountain range, at elevations in excess of 1,000 m; they flow east-west, parallel to the coast, in rather narrow and rugged valleys. In the part consisting of its source streams, it is known as the Upper Paraiba.

After the confluence of its source streams, the Paraiba continues for about another 45 km, all the way to Guararema (SP), in a general east-west direction. In this region it describes a real half-turn [about-face, U-turn], continuing from here, in a west-east direction, parallel to the coast, until it reaches its mouth. Up to the region of Itaocara (RJ), the southern Paraiba reveals the characteristics of a plateau river and runs through a channel which, in some sections, looks rather gentle and is full of meanders while in other sections it flows more rapidly in a number of rapids and waterfalls. In this section it is known by the name of Middle Paraiba. Between Jacarei (SP) and Cachoeira [waterfall] Paulista (SP), it runs through a long Tertiary deposit, with a slightly declining profile. The Paulista waterfall, at Itacoara, drops about 450 m and in some sections the bed is carved into

the crystalline bed rock, as in the case of the region of Sapucaia (RJ).

After the region of Itaocara, it looks like a plains river and flows gently to its mouth. This last section is called the Lower Paraiba.

From the confluence of its source streams all the way to the mouth, it is about 900 km long. The Paraitinga, the longest of its source streams, is about 200 km long.

(b) The Tributaries:

In addition to its abovementioned source streams, we might mention the following tributaries:

On the left bank:

The Paraibuna, which has its source in Santos Dumont (MG) and which flows for about 180 km through the territory of the Mining State; among its tributaries we might mention the Peixe and Preto rivers, the latter constituting the boundary between the states of MG and RJ for almost its entire length; the Paraibuna flows past [through] the city of Juiz de Fora (MG);

The Pomba River, almost 300 km long; its basin spreads out almost throughout the entire territory of the Mining State and the river finally flows into the Paraiba near Itaocara, at the dividing line between the Middle and the Lower Paraiba;

The Muriae, about 250 km long; the lower course of this river is on the territory of the state of Rio de Janeiro where it reveals the characteristics of a plains river.

On the right bank:

The Pirai which flows through the lowland region situated between the Sao Paulo section of the Mar mountain range and the Orgaos mountain range; as we study the relief of this part of the country, we note that this river valley has been earmarked for the construction of transportation routes and for a reservoir dam for the production of electric power; we will see how important this river is, because of this situation, later on;

The Piabanha is about 80 km long and flows past Petropolis (RJ); its main tributary is the Paquequer which is 75 km long and flows through the city of Teresopolis (RJ);

The Dois Rios, formed by the confluence of the Negro and the Grande rivers.

Almost all of these tributaries are pleateau [highland] rivers and have rather narrow valleys between the crystalline foothils; here we have many waterfalls and rapids with a considerable water power potential. The

rivers here are rather interesting from this viewpoint because they flow parallel and very near to the coastline, thus facilitating the transposition of the dividing line [water divide] with a great difference in elevation, such as in the case of the Paraibuna (source) stream and the Pirai.

This does not apply to the lower section of the Muriae and the Dois Rios rivers, after the confluence of their source streams.

1.4.2. Lakes and Canals:

In the region of the delta we have numerous small lagoons. The city of Campos is linked to the Feia lagoon by a canal; this canal is not included in the basin and it is, in turn, connected to the lagoon at Macae. The entire area is known as the Macae-Campos canal; it is about 100 km long and facilitates waterway connection between these two cities.

In addition to the abovementioned lagoons and the canal, we might also mention the dams which have been built in the region of Pirai-Barra do Pirai (one on the Paraiba River, at Barra do Pirai; the other on the Pirai River; the third one is located along the divide); these dams were built for future water power utilization. The flooded area, which would not appear to be too big in the case of each of these dams, individually, nevertheless is quite considerable when added up.

1.4.3. Waterfalls:

The principal waterfalls, from the water power potential angle, are the following:

-- Paraiba River: Island of Pombos, 160,000 hp; Sapucaia -- 125,000 hp, and Funil -- 40,000 hp;

-- basin of the Paraibuna (tributary): Marmelo, on the Paraibuna River -- 16,000 hp; Cachoeira -- 80,000 hp and Picada -- 21,000 hp, both of them on the Peixe River; finally, we have the Areias -- 22,620 hp, on the Jacutinga River, a tributary of the Preto River;

-- Piabanha River: Alberto Torres -- 15,450 hp;

-- basin of the Pomba River: Cidade, on Pomba River -- 10,000 hp; Maria de Barros, on the Piau River -- 13,320 hp; and Meia Pataca, on the Meia Pataca River -- 11,900 hp.

In addition to these waterfalls we must also consider the possibility of tapping sources across the divide which would further increase the water power potential. These possibilities exist in the interior of the basin, between the basins of the Parana and the Paraiba and within the basin of the Paraiba and along the rivers on the litoral.

The main points that have been studied here would yield the following potentials:

-- in the interior of the basin: the Preto River -- Pirapetinga River (RJ) with 150,000 hp; and the Alegre brook -- Piquete River (SP) with 72,800 hp;

-- from the basin of the Parana to the basin of Paraiba: the Paraitinga River (a tributary of the Tiete) -- Paraiba River (SP) -- 750,000 hp; the Sapucai River -- Moreira (SP) -- 60,600 hp; the Grande River -- Espraiado River (tributary of the Preto) (MG) -- 87,000 hp; the Grande River -- and the rather wide Vermelho stream (basin of the Paraibuna -- tributary) (MG) -- 90,600 hp; and the Mortes River -- Pomba River (MG) -- 118,200 hp;

-- from the basin of the Paraibuna to the litoral: Paraibuna River (source) -- Ubatuba (SP) -- 70,000 hp; and the Paraiba River -- Pirai River -- Lajes wide stream (RJ) -- 1,000,000 hp.

The total potential of the basin would appear to exceed 3 million hp or roughly 14% of the water power potential of Brazil.

1.4.4. Navigability

The basin looks rather unfavorable from this viewpoint, especially as regards the tributaries; of these only the Muriae would appear to reveal conditions for navigation in its lower third, although they would appear to be rather precarious at that.

The principal river contains three navigable sections: from the mouth to Sao Fidelis; between Barra do Pirai and Resende and between Cachoeira Paulista and Jacarei; the latter two sections will lose their significance completely after the construction of the railroad and the highway running along the river.

The river mouth reveals conditions that are rather unfavorable to navigation.

1.5. Climate (Figure 3)

We have three different types of climates prevailing in the three parts of the principal river.

Along the Upper Paraiba, using the classification by Koppen, we find the Cwb climate prevailing (high elevation tropical climate with cold summers and summertime rain) in the basin of the Paraitinga; next we have the Cfb climate (subtropical with cold summers) in the basin of the Paraibuna (source) and in the Bocaina mountain range.

Along the Middle Paraiba we find predominating the Cwa climate (high elevation tropical climate with hot summers and summertime rainfall). As we reach the foothills of the Mantiqueira and Orgaos mountain ranges, elevation makes the summer more gentle and we then predominantly find a Cwb climate; in the massif of Itatiaia and in the higher portions of the Orgaos mountain

range we have a transition to the Cfb climate. Along the southern boundary of the basin of the Pirai River and the Grande River (source stream of the Dois Rios River) we have Cfa climate (subtropical with hot summer). Along the channel of the main river, below the region of Tres Rios and in the lower basin of the Pomba River, we can observe Aw climate (hot and humid with summer time rain).

Along the Lower Paraiba we find the Aw climate predominating; we observed this type of weather at the end of the section of the Middle Paraiba. We observe the Cwa type of climate only in the head waters of the Muriae and in the Santo Eduardo mountain range.

The temperatures are quite favorable here. The average of the maximum temperatures here is between 26° C and 28° C; it rises a little in the upper section of the Middle Paraiba and in the region of the Lower Paraiba; the hottest region, with average maximum temperatures between 32° C and 34° C, is the region of Itaocara, at the confluence with the Pomba. In the high regions of the Bocaina, Orgaos, and Itatiaia mountain ranges, the temperatures drop considerably and in the last-named mountain range it is between 14° C and 16° C.

The average minimum temperatures are between 15° C and 17° C and this figure goes up to 19-21° C along the Lower Paraiba. As we go higher up, particularly in the massif of Itatiaia and in the mountain ranges of Bocaina and Orgaos, these averages drop and in the latter two mountain ranges they are around 10° C.

There is heavy rainfall in this area. Along the Lower Paraiba and in a rather narrow strip along the Middle Paraiba, to the south of the principal river and extending from Vassouras (RJ) all the way to Cantagalo (RJ) -- regions in which we have somewhat less rain in this basin [regions with the least rainfall in the basin] -- the annual precipitation is between 1,000 and 1,250 mm. In the regions of the massif of Itatiaia and its foothills, in the Sao Paulo section of the Mar mountain range, and in the Orgaos mountain range, the rain gauge indications are rather high and here we have an annual precipitation in excess of 2,000 mm; in some points along the last-named mountain range we get as much as 2,500-3,000 mm.

1.6. Vegetation

The area of the basin originally was heavily covered with a dense tropical broad-leaf forest almost all over. We had a typical litoral vegetation only in the strip to the east of the city of Campos (RJ).

Human action can be detected all over the basin, principally in the form of coffee plantations; as a result, the forest has been almost completely devastated and, because of the predominant soil type (a rather weak layer of decomposed Archean), as well as the rather inefficient cultivation method and the violent action of erosion, we can say that the current vegetation cover consists almost absolutely and predominantly of poor pasture land; here we find a variety called the "Guinea grass" on a larger scale. The tropical forest today is confined to some of the lower regions of the valley, to the

tops of some of the higher elevations, and to the slopes of the mountain ranges bordering on the basin; some of the areas have been protected as a result of their conversion into national parks (Itatiaia, for example) and this is why what little remains of the forest is a target for random devastation.

1.7. Over-all Estimate

The analysis of the physiographic factors of the basin of the southern Paraiba reveals that it is located relatively around the centers of Sao Paulo, Rio de Janeiro, and Belo Horizonte; this makes the basin extremely important.

The nature of its soil predominantly promotes agricultural activities but we must note the rather negative aspect of the rather easy exhaustion of this soil type; combined with other factors, this has heavily cut down on some of the initially existing possibilities here.

The rather unfavorable conditions presented by the relief, particularly those that are reflected in the transportation problem, however, are practically offset in view of the rather important location of this area which we emphasized above.

The hydrography, over-all, reveals a considerable water power potential, including waterfalls and places where water could be switched across the divide; on the other hand, the navigability of these rivers and streams is very insignificant.

The climate is very good throughout the entire area and would permit settlement without restriction. Some of the higher elevations reveal conditions that are very suitable for summer vacation spots and health resorts.

In summary, some of the physiographic aspects as such are so favorable that we can say that the area of the basin is extremely important.

2. Historical and Population Aspects

2.1. Historical Aspects

The basin of the southern Paraiba has been influenced by almost all of the principal events in the historical development of Brazil.

The region of the lower Paraiba, which was a part of the captaincy of Sao Tome, was the scene of the first colonization attempts during the first half of the 16th century although there are indications that this effort was launched in 1539 with the building of "Vila da Rainha" where the township of Sao Joao da Barra is located today, right at the mouth of the Paraiba.

The creation of the captaincy of Campos dos Goitacases, on the land of the old captaincy of Sao Tome, and the founding of the city of Campos, in

the middle of the 17th century, marked the firm establishment of colonization here; the region then began to flourish during what was called the "sugar cane period" along with the captaincies of Pernambuco and Itamaraca.

Sao Paulo, during the "Indian hunting period," was the point of departure for the pioneers who headed for the Upper Paraiba and the upper portion of the Middle Paraiba. Proceeding from the Middle Paraiba, via the head waters of the Uppper Paraiba, following along the trail of the Goianases [pioneers from Goias], they reached the bay of Parati after crossing the Mar mountain range; this helped establish the first major link between Sao Paulo and Rio de Janeiro.

In the upper portion of the Middle Paraiba, during the "gold rush," we had many pioneer groups who tried to negotiate this area, heading for Minas Gerais; this also led to the establishment of a few major towns among which we might mention the following: Jacarei, Taubate, Pindamonhangaba, Guaratingueta and Lorena.

During the "gold rush" the link between Rio de Janeiro and Minas Gerais -- which initially was accomplished via the "old road" and which ran along the previously mentioned Goianases trail, running through Parati -- began to shift to the "new road," crossing the Orgaos mountain range in the region of Petropolis and following the valleys of Piabanha and of the Paraibuna (tributary). At that time, the link between Rio and Sao Paulo was roughly laid out along the current highway via the access route at Itaguai leading to the first step (Cacador [hunter] road) and the crossing of the Araras mountain range, corresponding to the depression between the Mar and Orgaos mountain ranges, which we mentioned in connection with our study of the terrain relief.

On the eve of the independence of Brazil, the gold rush was just about exhausted. This led to the development of agricultural activities and, in spite of the importance of the can cultivation areas at that time, a new crop developed and grew rapidly all over the country; this was the coffee crop. This coffee plantation drive now spread out and populated almost the entire interior above the Mar and Orgaos mountain ranges; coffee plantations brought a rather uniform soil utilization pattern to the valley, especially along the Middle Paraiba. For a long time, the basin of the Paraiba produced almost our entire coffee output.

During the second half of the 19th century, the valley, still a very important coffee-growing center, was improved considerably with respect to transportation. The "union and industry" railroad line between Petropolis and Juiz de Fora (1861), a rather daring enterprise at that time, for a good distance runs along the current BR-3 [highway], linking these two cities; the railroad link between Rio and Sao Paulo (1877) was built all the way up to the plateau, through the depression between the Mar and Orgaos mountain ranges; and the railroad link between Barra do Pirai (served by the Rio-Sao Paulo railroad) and Lafaiete (MG -- at that time known by the name of Queluz de Minas) (1884), represented undertakings which greatly helped develop this valley.

After the coffee plantations were exhausted, these producer regions in the valley of the Paraiba rapidly and radically deteriorated. At that time, coffee had spread to other areas which did not suffer from this phenomenon so intensively. The decline here was speeded up tremendously as a result of the manpower shortages at the end of the century and the complete abolition of slavery; this just about ruined the plantations, along with the manpower shortage; soil utilization methods were not changed and new working conditions were not worked out.

Agricultural activities were thus reduced to a minimum and we now find predominating mostly extensive milk cattle raising and related activities; the Paraiba valley thus went through a phase of real stagnation.

After the dawn of the 20th century, industrial activities were launched in this area; one of the two centers here was the mining city of Juiz de Fora, mainly as a result of European (primarily German) immigration; these people settled here during the decade beginning in 1890. This was also the place where the first hydroelectric power plant in South America was built; here, also, sprang up a textile industry which earned that city the nickname of the "Brazilian Manchester."

Simultaneously, the development of the industrial centers of Rio and Sao Paulo, outside the basin, but very near it, brought about a situation in which more and more people were once again attracted to the Paraiba basin, especially because of the available water power. Hydroelectric power plants began to spring up all over and more and more resources were tapped here; this gave the valley a tremendous upswing, especially when the power systems were tied in with those of Sao Paulo and Rio.

The valley thus began to emerge from the coffee crisis as a result of industrial development although at that time the growth rate was still rather slow.

When plans were made for the establishment of a heavy steel industry facility in Brazil, the valley of the Paraiba revealed conditions which turned it into an ideal spot; the region around Volta Redonda was selected for this facility; from a small town of 6,000 people in 1940, it grew to 32,000 inhabitants in 1950. According to all indications, this tremendous growth was influenced primarily by the following factors: the proximity of the major consumer centers; location half-way between the mines (in Minas Gerais) and the ports of debarkation and embarkation (Santos and Rio de Janeiro); a magnificent land transportation network; abundant and cheap power (Rio-Sao Paulo system); skilled manpower; and large supply of industrial water (Paraiba River).

We can say that the founding of Volta Redonda launched a new industrial phase in the valley which is currently keeping up with the over-all national growth rate.

2.2. Population Aspects

The basin of the Paraiba is heavily populated; we might estimate its total population at about 3 million; this would give us a population density of more than 47 people per sq km. There is a marked balance between the urban and the rural population.

The principal population nuclei (including only the urban population), on the basis of the 1960 census, are the following:

-- in Minas Gerais: Juis de Fora (128,300 inhabitants), Muriae (25,600), Uba (25,400), Cataguases (24,800), Santos Dumont (24,100), Leopoldina (21,500), and Alem-Paraiba (19,300);

-- in the state of Rio de Janeiro: Campos (132,000), Petropolis (120,000), Volta Redonda (84,000), Nova Friburgo (55,600), Barra Mansa (51,500), Teresopolis (29,700), and Itaperuna (22,700);

-- in Sao Paulo: Taubate (65,900), Sao Jose dos Campos (56,800), Guaratingueta (38,300), Jacarei (28,100), Cruzeiro (27,000), Lorena (26,000), and Pindamonhangaba (20,100).

The population does not reveal any special characteristics here, except for the rather great degree of miscegenation. The groups of European immigrants (mostly Germans, especially in the regions of Juiz de Fora, Petropolis and Nova Friburgo)and Asian immigrants (mostly Japanese, heavily concentrated in the Sao Paulo portion of the valley), contributed greatly to the settlement of the valley; nevertheless, no major settlements of foreigners [unassimilated immigrants] continued to exist here.

Some of the cities have rather interesting and worthwhile educational systems; the factor of education here is most closely tied-in with the psychological factors; a few of these institutions are nationally famous, such as the college at Nova Friburgo, in the city by the same name, and the ITA (Aeronautical Engineering Institute) at Sao Jose dos Campos; in this valley, likewise, at Resende, we have the magnificent Military Academy of Agulhas Negras, an establishment where Brazilian army officers are being trained.

2.3. Over-all Estimate

The historical antecedents indicate that this region has played a major role in the development of the nation as a whole.

As far as the population potential is concerned, speaking in terms of population density and type of settler, we can say that this is a quantitatively and qualitatively high-level area.

3. Economic Factors

3.1. Extraction Industry

3.1.1. Mineral Extraction

Fuels:

The basin does not reveal any deposits of petroleum or mineral carbon.

In the Tertiary basins of the Middle Paraiba we have large deposits of oil-containing layers in the form popularly called (by the way incorrectly, so) pyrobituminous schists.

The reserves of petroleum here have been estimated at about 2 billion barrels; compared to the other Brazilian fuel reserves, this would be about 3 times the known petroleum reserve of Bahia and this could also be compared to the energy of about 1/3 of our already identified Brazilian carbon reserves.

Extraction as such does not involve any problems because the horizons are almost on the surface. However, the selection of a product that can be processed and its actual processing do involve problems. The selection involves problems because of the arrangement of the richer layers between poorer and sterile horizons; the processing as such [that is to say, the refining] would involve problems of a technical and economic nature and we are still running tests here.

The production of liquid or gas fuels by means of the distillation of the schist has been experimented with since the last century in various places where deposits are located. The companies which tried to develop this on an industrial scale, by means of small plants, were inspired more by optimism than by scientific background and many times they employed a rather primitive technology; these companies have been shut down and, what is even worse, they created the mistaken idea that industrialization here with bituminous schists as an economic basis would not be worth while.

In 1952 the government set up the CIXB (Bituminous Schist Industrialization Commission) which, at Tremembe, near Taubate, established an experimental station for the processing of this material; here realistic tests can be conducted. The SIX (Superintendency of the Industrial Development of Schist [Slate]), which replaced the CIXB, now a part of Petrobras, through its processing division, developed a process (called Petro-Six) which proved highly efficient in the pilot plant and whose applicability will be checked in a prototype plant to be built by Petrobras in the area of the basin, at S. Mateus do Sul (PR), where we have another major deposit of slate (Irati formation).

The superintendent of the SIX, in a statement released in 1963, thought his team had been successful in what he called "meeting the challenge" presented to his group.

We must however keep in mind that, at least for the beginning, Petrobras will give priority in these projects to the regions outside the basin or, more specifically, to the areas formed by the Irati formation.

In addition to slate, the basin also reveals deposits of peat and lignite. There are peat bogs in the townships of Campos, Barra Mansa, Resende, Bom Jardim (MG), Pindamonhangaba, Taubate and Cacapava. Some of these are rather small-scale and local operations, except of course for the period of the last war (between 1942 and 1945), when there was a great shortage of fuels and when the EFCB had to go into the peat bogs of the last-named three townships. There are deposits of lignite in the regions of Quatis, township of Barra Mansa, and in the township of Cacapava. The first-named area is not at all important and the second area was effectively operated only during the fuel shortages in 1918-1920 and 1944.

Mines and Minerals:

The geological structure of the basin has turned out to be rather unfavorable from the viewpoint of mines and minerals.

The only deposit which is really worth mentioning is marble and here the principal producing townships are Mar de Espanha (MG), Campos and Cantagalo (RJ). The first named is the biggest producer in Minas Gerais, accounting for about 1/3 of the output of the state; the other two are the principal producers in the state of Rio, with a volume approximately equal to that of Mar de Espanha. Altogether, the basin provided for less than 1/3 of the Brazilian output with a figure of 12,000 tons in 1961.

The basin also reveals the following deposits:

-- Limestone, generally found almost all over the area;

-- Pyrite (sulfur), in Itavera (RJ);

-- Clay particularly kaolin and "tagua"; kaolin at Barra do Pirai, Valenca, Sapucala and Sumidouro, in the state of Rio, and in Juiz de Fora, Bicas, and Mar de Espanha in Minas Gerais; and "tagua" in Pindamonhangaba and Taubate, in Sao Paulo;

-- Feldspar, at Juiz de Fora;

-- Quartzite, at Jacarei;

-- Graphite, in Sao Fidelis, Padua, and Itaperuna (RJ);

-- Diatomite, at Campos;

-- Mica, at Matias Barbosa, Bicas, and Lima Duarte, (MG);

-- Mickel, at Tres Rios;

-- Niobium and tantalum, in the form of columbite and tantalite at

Uba, Pomba, and Muriae (MG);

-- Zirconium -- Zirconite, at Sapucaia;

-- Thorium, along the Pomba and Muriae rivers, in the townships of Sapucaia and Valenca (RJ) and along the litoral we have already identified deposits of thorium-bearing monazite although there is disagreement as to the real possibilities of these deposits.

3.1.2. Vegetable Extraction

With the almost total devastation of the forest reserves in the area, we find that vegetable extraction is almost extinct here.

3.1.3. Fishing

In spite of some of the rather suggestive names, such as the Peixe, Pirai and other rivers (meaning fish river, in Tupi), the rivers of the basin cannot be considered very rich in fish. The office of the Secretary of Agriculture of Sao Paulo, with some success, tried to introduce some of the more attractive species. As a result of this effort, we now can find catfish all along the Middle Paraiba.

3.2. Agricultural Production

With the exhaustion of a large portion of the area of the basin, due to the helter-skelter cultivation of coffee, we find that agricultural activities are confined to a rather restricted area. We might however mention the following major aspects here:

-- subsistence farming; extensive throughout the entire area which can be considered self-sufficient from this viewpoint; there is a surplus in some products and these surpluses are shipped to the major centers in Rio and Sao Paulo; here we might mention rice which is cultivated very extensively in the Sao Paulo portion of the Middle Paraiba, and in the basin of the Muriae where we have, in addition, corn, potatoes, beans, tomatoes, and garden vegetables in general;

-- sugar cane; the region of Campos, the basin of the Pomba River and the region of Resende, particularly the former, are the major producer centers here, accounting, altogether, for about 12% of the Brazilian output;

-- coffee; in spite of the drop in this industry, the basin still reveals a rather considerable coffee production;

-- cotton; we have a number of cotton plantations here, particularly in the zones of Muriae, Cantagalo, and along the terraces following the bed of the Middle Paraiba;

-- fruit cultivation; here we have a wide variety of species with a number of exportable surpluses or with other surpluses that can be used in

the candy industry; by way of example we might mention the regions of Sapucaia and Uba which are famous for the quality and quantity of their mangoes; and of course we must not forget the zone of Campos which is a major producer of excellent guavao paste;

-- flower cultivation; here the cities of Petropolis, Teresopolis and Nova Friburgo are outstandingly successful in the production of flowers for the market of Guanabara, particularly in the orchid line;

-- eucalyptus; one of the ways in which the land is used here involves the growing of eucalyptus trees; this practice however must not be confused with the kind of conservationist reforestation which this valley needs so badly; what this area needs is a program for the immediate and over-all increase in timber to replace the exhausted forest reserves; this is particularly true of the Sao Paulo section of the Middle Paraiba where the eucalyptus is planted on a major scale; from this tree we get lumber, charcoal, railroad ties, construction material, and raw material for paper production.

3.3. Animal Husbandry

Here we have extensive beef cattle ranches, specializing particularly in raising milk cows for dairies; this ranching industry has replaced the coffee plantation sector, especially in view of the manpower shortage and the low yield from the exhausted soil. But this did not help in the economic recovery of the area because animal husbandry here is being conducted in a rather inefficient fashion, with a few honorable exceptions. As a rule, there is no effort being made to raise pure-bred cattle; the stable facilities are very poor and the pastures are likewise very poor. Nevertheless, the valley does have a considerable dairy output and here we might mention the townships of Santos Dumont, Tres Rios, Vassouras, Resende and Taubate; here we have not only a large volume of milk but also derivative products (cheese, cream, butter, buttermilk, etc). Some of the beef cattle are slaughtered but most of the meat is consumed in the valley; beef cattle is also used for field work although on an ever smaller scale.

In addition to beef cattle, the basin reveals large herds of pigs as well as poultry farms. The herds of horses, mules, sheep, goats, and so on, are relatively small in number and importance.

3.4. Industrial Production

The basin of the Paraiba, even before the CSN, revealed a rather considerable industrial development; but it grew tremendously after the establishment of the CSN and today we have a large number of industrial facilities scattered all over the area, featuring a wide variety of activities. We can summarize the situation here as follows:

Electric Power. We have seen that the Paraiba River and its tributaries offer good possibilities for electric power production. However, most of the water bodies here do not permit the establishment of major facilities; they can therefore only supply some of the local needs, as in the case

of the Piabanha, Paraibuna (tributary) and Preto rivers which, with a few smaller electric power plants in operation, now supply the regions of Petropolis, Juiz de Fora, and Tres Rios.

The major undertakings here primarily involve the tapping of water resources on the other side of the divide; this is true for instance of the region of Barra do Pirai where water is being pumped from the Paraiba River to the dam along the Pirai River; in the second section of this pumping system, the water is moved from the dam, across the divide, and it is then finally supplied to the installations at Lajes. Most of the water supplied to the power plants here comes from the basin and we might take a quick look at them here. The most important ones are the following:

Nilo Pecanha, now operational, turning out 330,000 kw.

Fontes, now operational, producing 154,000 kw, with a new plant being programmed here for a final output of 325,000 kw.

Ponte Coberta, producing 45,000 kw with another 45,000 kw capacity under construction.

Along the Paraiba River we might mention the following plants:

Paredao-Funil, under construction, in the Resende (RJ), for a planned output of 210,000 kw.

Ilha dos Pombos, now operational, supplying 162,000 kw.

Along the tributaries we might mention the following:

Sobraji, programmed for 51,000 kw, on the Paraibuna (tributary) River.

Picada and Cotejipe, both of them on the Peixe River, in the basin of the Paraibuna (tributary), designed for 36,000 and 14,000 kw, respectively.

Piau, on the Piau River, basin of the Pomba River, now turning out 19,000 kw with another 9,000 kw facility under construction.

Mauricio B, on the Novo River, basin of the Pomba, now turning out 10,000 kw, with another 15,000 kw under construction.

Areal, on Piabanha River, now operational and producing 18,000 kw.

Power plant projects are now under study at Simplicio and Sapucaia, both of them on the Paraiba River, in the region of Sapucaia, programmed for 200,000 and 400,000 kw, respectively.

After all of the projects now under construction or on the drawing boards have been completed, the Paraiba basin will turn out the rather appreciable total of 1.8 million kw, including the smaller plants. Of course, a major portion of this potential will be supplied to the state of Guana-

bara, which is outside the basin; nevertheless we must point out that the connection of that system with the Sao Paulo system, which has already been established, and with the Furnas system, to be established shortly, the basin will have tremendous possibilities for supplying its own area.

Metallurgy:

(a) Heavy Industry:

In our discussion of the historical background of the basin we saw that the region of Volta Redonda was selected for the establishment of the National Heavy Industry Company whose development marked Brazil's debut in the heavy industry sector. This facility became operational in 1946 with a figure of 250,000 t of steel per year; in 1962, the figure had gone up to 1,250,000 t. Most of the output goes to consumers in Rio and Sao Paulo. This heavy industry center gets its mining products from Minas Gerais and its coal from Santa Catarina, although other coal shipments come from abroad.

In addition to the CSN [National Heavy Industry Company], we might mention the Barra Mansa Heavy Industry Corporation and the Barbara Metallurgical Company, both of them located in the city of Barra Mansa, in the state of Rio de Janeiro. In 1962, the former turned out 67,000 t of steel whereas the production of the latter is intended for its own metallurgical uses. Both of them get minerals and mining products from Minas Gerais whereas the fuel in the case of the former, is primarily petroleum and, in the case of the Barbara plant, vegetal coal.

(b) Nonferrous Metals:

The CESBRA (Stanniferous Company of Brazil) has a plant at Volta Redonda where it processes mining products from various sources, particularly cassiterite. Together with the Companhia Industrial Fluminense [Rio de Janeiro Industrial Company], which is based outside the region of the basin, in Niteroi, it is responsible for the production of tin in the state of Rio de Janeiro; in 1961 the output was 1,523 t, more than 98% of the Brazilian total output.

-- Non-metallic Minerals. This basin is the home for a rather diversified industry which processes these minerals; here we might mention the production of Portland cement, with a factory at Campos (Cimento Paraiso) and another one at Volta Redonda (Cimento Tupi); the latter is of the siderurgical type; a number of towns have factories turning out cement products; various other products, including refractory bricks, ceramic products, and so on, are also produced here in a number of towns.

-- Chemical Products. In its coking plant, the CSN turns out various by-products which in the past had to be imported; here we might mention benzol, toluol, naphthalene tar, creosote oil, anthracenic oil, xylol, disinfectant oil, ammonium sulfate, pitch, solvent naphtha, etc. In addition to the CSN we also have the army's power plants (the President Vargas Factory at Piquete, SP) and the Dupont Company (at Barra Mansa) as well as the major installations which the big Sandoz Company is erecting at Resende;

here the company will turn out its entire line of products (chemical products for textiles, leather, paper, and other items).

-- Transportation Equipment. Here we must really emphasize the auto factory of General Motors, at Sao Jose dos Campos, and the National Railroad Car Factory, at Cruzeiro.

-- Processing Industries: Food Products. We can find food products plants almost in the entire area; here we might especially emphasize the dairy industry in a number of townships in Minas, and in the states of Rio and Sao Paulo; next we have sugar refining, particularly at Campos, Resende and Juiz de Fora; we also have candy factories here, primarily at Campos and Taubate; next we have cracker and biscuit factories, particularly the factories at Jacarei and Petropolis; we also have many rice, coffee, corn, and cassava processing plants and of course beverage plants.

-- Textiles. Here we might mention especially the townships of Taubate, Juiz de Fora, Jacarei and Sao Jose dos Campos, although we have other big plants in a number of other towns.

-- Metallurgical Sector. A number of factories have been established in the basin for the purpose of utilizing the sheet metal and steel plate turned out by Volta Redonda, in addition to the Barbara Metallurgical Company which will turn out forged material and iron pipe for various purposes. Among the other installations we might mention the heavy-machine building plant at Taubate, in Taubate, the Babcock boiler factory, in Resende, and various other steel plants in the area.

3.5. Transportation Routes

3.5.1. Land transportation: Railroads (Figure 4). The basin of the Paraiba is served by one of the best railroad networks, including the Central Railroad of Brazil, the Leopoldina railroad, the Rede Mineira de Viacao, and the Campos do Jordao railroad.

The EFCB (Central Railroad of Brazil) comes into the basin, from Rio de Janeiro, on a standard [wide]-gauge, double-track line, reaching the valley through the depression between the Orgaos mountain range and the Sao Paulo section of the Mar mountain range, extending all the way to Barra do Pirai. Up to that point it corresponds to the section jointly used by the TPS, TPO, TPC, and TPN [sic].

Here it splits, continuing with the wide-gauge track, although this time single-track, toward Barra Mansa (section jointly operated with the TPS and TPO) and toward Belo Horizonte (together with the TPC and TPN). From Barra Mansa the EFCB continues to Sao Paulo, constituting the TPS.

The EFCB then operates the so-called auxiliary line; this is a narrow-gauge line linking Japeri outside the basin, to Tres Rios and some branch lines on either side of TPC; here we might mention the L 32, between Benfica

and Lima Duarte (MG) which in the future is to be linked with the TPO.

The Rede Mineira de Viacao links Angra dos Reis, on the shore, to the southern part of Minas, crossing the TPS at Barra Mansa and constituting, from here on, the narrow-gauge and single-gauge track TPO. In this same fashion it then runs on to Cruzeiro (SP), connecting the TPS to the TPO in the southern part of the state of Minas, outside the basin.

The Leopoldina railroad connects Rio de Janeiro and Niteroi with Vitoria (ES), crossing the basin at Campos, along the Lower Paraiba, constituting the T4, which is a narrow-gauge and single-track line. In the same way it links Rio de Janeiro to the forst zone of Minas, climbing over the mountain range by means of a cog rail system, to Petropolis, constituting railroad link L30. This L30 line links up with the TPC at Tres Rios, as well as Juiz de Fora, through the L31 line -- Furtado de Campos -- and Juiz de Fora, continuing on to Ponte Nova, outside the basin.

Between the T4 and the L30, the Leopoldina railroad is made up of a network of several branches.

The Campos do Jordao railroad links Pindamonhangaba, on the TPS, with Campos do Jordao.

Highways (Figure 5)

The basin is also served by the magnificent highway network and here we might single out the following:

BR-2 [highway] -- Rio -- Sao Paulo, paved, two-lane highway now under construction;

BR-3 -- Rio -- Belo Horizonte, paved;

BR-4 -- Rio--Bahia, paved; the section between Teresopolis and Alem-Paraiba is now under construction and for the time being this section is being replaced by BR-3 between Rio and Areal and by BR-83 between Areal and Alem-Paraiba;

BR-5 -- Rio--Vitoria, crosses the basin at Campos; paved up to Campos and from here, to the boundary of the basin, it is now in the process of being paved;

BR-32 -- Sao Joao da Barra--Campos--Muriae--Cataguases--Juiz de Fora --Caxambu, under construction, finished up to Muriae, with only a few sections paved;

BR-57 -- Barra Mansa--Tres Rios, paved, links BR-2 to BR-3 and through BR-83 also to BR-4;

BR-58 -- From Resende to Caxambu, paved;

BR-76 -- Lorena--Piquete--Itajuba, paved;

BR-77 -- Pindamonhangaba--Campos do Jordao--Itajuba;

BR-82 -- Leopoldina--Uba;

BR-83 -- Areal--Alem--Paraiba, paves, currently used as replacement for the section of BR-4 which is now under construction.

In addition to the federal highways, we have a number of state highways which are in rather good condition.

3.5.2. Waterways. The waterways are rather unimportant here although we might mention navigation on the Lower Paraiba, between Sao Joao da Barra and Sao Fidelis.

3.5.3. Airways. Although we do not have any regular lines serving the valley, many cities have good landing fields and have a rather heavy volume of air traffic involving small private airplanes and air taxi service by the air lines.

3.6. Over-all Estimate

The economic factors in this area would appear to make the basin of the Paraiba extremely important in the future development of the nation's economy.

The basin is a supplier of animal husbandry and agricultural products for the major centers of Rio and Sao Paulo; its supporting and basic industries activities, particularly hydroelectric power and the product line of the CSN make it a rather important part of the country; next we might mention its late development in various sectors of the industrial field as such; it also has a magnificent transportation network and we would certainly not be exaggerating if we were to say that this is one of the up and coming economic regions of Brazil.

4. Political Factors

There are no political factors that would appear to have any major influence on the problems of the basin. The recent movement of the capital of the republic to the interior and the subsequent creation of the state of Guanabara, to all appearances, did not have any positive or negative effects that are worthy of mention here.

5. Conclusions

On the basis of our analysis of all of the various factors involved in the basin of the southern Paraiba, we might come up with the following conclusions:

The basin reveals predominantly favorable factors in all aspects;

Among the favorable aspects we might mention the position of the area with respect to the major centers of Rio, Sao Paulo, and Belo Horizonte, the nature of its predominant soil types, the water power potential and the weather;

As far as the historical background goes, we mentioned that the basin participated in almost all of the major events marking the economic development of the nation;

Its manpower potential is quite high, both quantitatively and qualitatively;

Among the economic factors we might mention the diversification of activities in the valley and the magnificent transportation network available there; we might also mention the importance of the basic industries and the processing industries which are located in this basin;

Among the unfavorable factors we must keep in mind that these factors are almost entirely cancelled out by others which, because they are so tremendously favorable, more or less counterbalance the unfavorable factors; thus we can say that the difficult terrain relief of the basin and the rather precarious nature of its rivers, with the almost complete absence of navigable sections, did not prevent the establishment of a magnificent transportation network; besides, as we said before, we must always consider the relative position of this basin; the shortage of major mineral resources and the lack of a mineral extraction industry did not prevent the establishment of a heavy industry in the basin because there were some other very favorable factors which made this development possible.

In conclusion, finally, we can say that the basin is extremely important, compared to some of the other parts of the country.

The Araguaia-Tocantins Complex and the CIVAT

(Source: CIVAT [Inter-State Commission of the Araguaia and Tocantins Valleys].)

Introduction

We know, because of the shortage of financial and technical resources in Brazil, we do not have the proper conditions for an over-all and effective attack in all areas; this means that we must carefully select our projects and assign priority to the most important problems. We are sure that, if the criterion of priority were followed, Brazil's most underdeveloped area would not continue to be abandoned; yet, this is the area with the best outlook and it would be difficult to find another region that should have a higher priority than the valleys of the Araguaia and the Tocantins.

Among various supporting arguments we might mention the fact that, we already have a tremendous federal investment here in the form of the Brasilia-

Belem highway, that is, Highway BR-14.

Another very important fact is represented by the tremendous waterways running through the region; here we have immense possibilities for navigation at least for boats and ferries, if we do the proper kind of planning.

The factor of colonization and settlement is of course a very integral part of such other areas of activity as electric power, irrigation, port facilities, education, public health, etc.

Due to the tremendous variety of the problems, due to their enormous complexity, combined with the shortage of resources and the lack of time, we must closely coordinate and carefully plan the entire effort because that is the only way we can avoid duplication and failure.

Because of the tremendous importance of the problems of the region and because of the urgency of the solution of these problems for the states involved and for Brazil as a whole, an agreement was signed on 8 June 1962, in the city of Araxa, setting up the CIVAT for the over-all development of this fabulous valley.

Population

The area of the basin covers 884,440 sq km and is located in the state of Goias where we have the major portion of the territory or 49.0%; 21.7% are located in Mato Grosso, 15% in Para; 13.6% in Maranhao; and 0.7% in the Federal District.

The population of the valleys, according to the 1960 census, was 1,994,401 and today should be more than 2,000,000.

In the valleys of Araguaia and Tocantins we have 177 townships; of these 141 are located in Goias, 12 in Mato Grosso, 16 in Para, 7 in Maranhao, and the Federal District.

General Aspects of Production and of the Socio-Economic Situation

The region on which we are focusing our attention now has some unusually advantageous characteristics which we might describe as follows:

Linking the nearest foreign trade port to the capital of the Republic it has tremendous possibilities for agricultural development, for extraction, and for industrial development; this situation, by itself, would guarantee a high return on the investment.

In the North, in the state of Para, chestnuts, cocoa, and lumber are natural riches which would justify development projects and their results would certainly be immediately positive for the commerce and industry of Belem.

In the states of Goias and Maranhao, we have carbon mineral, palm trees, and mahogany which represent undeniable natural resources and wealth. In this zone we find areas which are already being exploited and which also reveal excellent features for animal husbandry.

With the opening of the Carolina-Balsas highway, highway BR-24, the entire highway network of the Brazilian Northeast was interconnected. The polygon of drought areas, in the region we are studying now, could be turned into a tremendous breadbasket, producing cereal crops, flour, and meat; the transportation facilities carrying these products could, on the return trip, bring salt, sugar, and crafts products. We must point out that the only hydroelectric power plant will be built in this area at Farinha (5,800 kw); this power plant will provide the electric power necessary for the development of the industries that will be based on the local resources. This area is endowed with all of the factors for a tremendous, we might almost say explosive development.

Still looking at this region (the 13th parallel), we have a natural tie-in with the highway system from Bahia. Along this entire section, mineral deposits are so plentiful that there would be no competition with agricultural expansion. In other words, the mineral deposits are so easily accessible that they would not interfere with a major agricultural expansion. Here a hydroelectric power plant will be built at Sao Felix (400,000 kw) and this will complete the supporting structure necessary for a high productivity level.

Animal Husbandry and Agricultural Situation and Possibility

Until now, the animal herds here have been developed without any technical or financial assistance. The local conditions only permitted extensive cattle raising and under conditions involving small manpower increments and very small investments. In spite of this, the cow herds in the region have been calculated at 6 million head, with an average concentration of 6.6 head of cattle per sq km. Under current conditions, it is impossible to develop cattle ranching in this region. Energetic measures must be taken in order to correct this situation; these measures must range from technical assistance all the way to manpower training and equipment for product processing, especially meat, milk and leather.

Hog products also have the most promising prospects here. Today we have an estimated 4 million hogs here, concentrated mainly in the northern part of the region. However here again we must take a series of steps in order to improve the product and its sale.

Other types of cattle raising and ranching, in smaller concentrations, but nevertheless economically quite promising, would include horses, mules, etc. We have about 500,000 horses and about 300,000 mules here. Next we must mention the poultry farms which, in this region, add up to about 6 million birds.

As far as agriculture is concerned, this region could really undergo

a tremendous and spontaneous development. Bottlenecks of course have interfered with a continuous flow of production especially as regards transportation, warehousing, sales, financing, and technical assistance; these are major disadvantages under which the farmers are struggling here; besides, the market is rather unstable.

The current output of the region is about 8.6 million bags of first-grade rice (the Goias area alone produces 6.4 million bags):; this by itself would justify a tremendous planning and resources concentration effort in support of certain specific and final solutions.

In addition to rice farming, we might also make a special study of our corn, bean and cassava crops, not only because of the current production volume (3 million [tons] of corn, 1 million [tons] of beans) but also because of the tremendous possibilities of expansion; this increase could certainly be the result of a policy that would provide security and stability for farm development and for the sale of the harvest.

We have practically no cotton or coffee production in the region. However, pilot crops indicate the exceptional quality of cotton that could be grown here and that would be comparable to the "long fiber" of the Northeast; as far as coffee is concerned, the coffee beans would certainly be comparable to the first-grade product turned out in the state of Sao Paulo; thus we see that both cotton and coffee have tremendous possibilities for the future here.

Mineral Resources and Reserves

Within the context of the tremendous economic potential of the basins of the Araguaia and Tocantins rivers, the mining resources and wealth of this region would be enough to call the government's attention to the feasibility of its participation in the development of a Brazilian basic industry here. Although she has one of the richest subsoils of the world, Brazil finds her economy constantly sapped by foreign currency expenditures used to pay for import of essential minerals that are needed by a country in a phase of industrial development. This brings out the urgent necessity for prospecting in the Brazilian subsoil; we must make the best possible use of our highly valuable minerals, including strategic minerals, and we must thus step up the industrial development of the country. In the region under consideration here, the known deposits of nickel, graphite, rock crystal, and asbestos, as we shall see later on, would appear to be enough to promote a tremendous improvement in the Brazilian import balance. We must also emphasize the great possibilities for the existence of coal, which is a decisive factor in the development of the Brazilian heavy industry.

Nickel. According to a report by the Bureau of Mines and the Brazilian Mining Production Department, nickel deposit studies in this region revealed the following information: although we have many different deposits, only 45 were explored. According to the opinion of William Pecora, head of the mission, these deposits revealed the following values: cubic content rigorously measured -- mineral with 4% nickel: 180,000 tons;

indicated reserves -- mineral with 2-4% nickel: 4 million tons; assumed reserves -- 1-3% nickel: 9 million tons.

The reserves for the entire "nickel-containing district" will not exceed 16 million tons, with 1-3% nickel.

"It is possible," said Pecora, "that this district might furnish as much as 5 million tons with an average of about 4% nickel and up to 1 million tons with an average of 6% nickel content."

As we can see, this is a deposit that is not only important from the Brazilian viewpoint but that is also quite large and quite important from the international viewpoint. In accordance with data extracted from the Bulletin of the Ministry of Finance, Brazil is a nickel importer, with a total of 1.5 million tons per year, although we have two plants that can turn out nickel in Brazil, the "Liberdade" and the "Morro do Niquel" plants.

According to prospecting done by the "Vatu" Company, the nickel consumer market in Brazil is liable to absorb 3,000-4,000 tons of electrolytic metallic nickel per year, for the production of inoxidable steel alloys, nickel-chrome, ferro-nickel, and finally a whole series of metallurgical products in which nickel is an important cost factor.

We also have all of the necessary conditions for the extraction of pyrite in the vicinity of Niquelandia or we can develop a project on the basis of the sulfur deposits in the township of Xambioa, in the northern part of the region.

With this short explanation we are trying to show the tremendous size of the investment and the economic significance of the nickel deposits in the Araguaia-Tocantins region.

Asbestos [Amianthus]. In the state of Goias we have a number of types of amianthus deposits: crysotile, crodocilite, and amphibolic amianthus. The first type is the one that is now being studied in the region of the valleys; here we have a deposit in the township of Uruacu, near the Sao Felix plant.

Prospecting has already been started in this region by the Sama Company, which is affiliated with the "Brasilit" group; a large deposit, estimated at at least 25,000 tons of fibers, has been discovered here.

By importing asbestos, Brazil wastes almost 5 million dollars a year. As we shall see, the establishment of an asbestos supply industry would be extremely helpful because we would be able to save a considerable amount in foreign currency.

Copper. Due to the lack of funds for prospecting, we have not found any economical deposits of copper in the region. We did prospect deposits in the township of Uruacu and the results did not indicate any economically

exploitable deposits. The only copper that we could extract right now in this region would be the sections in the deposits of garnierite in the township of Niquelandia which gives us a percentage of 0.5% copper in the nickel mineral; this would have to be extracted before the nickel could be properly sold.

Rock Crystal. This is a mineral which has been exploited in this region for quite some time and it was quite popular during the last world war. But the operation here is rather confused and there is no federal government financing here.

The rock crystal in this region accounts for at least 80% of the Brazilian output and 60% of the world output.

Although Brazil is a great exporter of rock crystal, it does import rock crystal cubes and sticks for optical purposes because it does not have an industry capable of processing this material.

The rock crystal producing townships in the region are: Xambioa, Araguaina, Pium, Araguacema, Cristalandia, Nazare, Pau-d'Arco and Sao Luis.

Gypsum. We have a deposit here in the township of Filadelfia and there are possibilities in some of the other townships of the region. The purity of the gypsum in this region is quite high; it is 95% pure calcium sulfate.

Manganese. Whatever there is in the region here is located in the township of Sao Joao d'Alianca, constituting some rather small deposits not exceeding 200,000 tons, with a percentage of 46.3% manganese, 1% iron, and 0.23% phosphorus. It is used in making special batteries containing manganese or electrolytic manganese.

This deposit is too small to establish a separate mill here; besides the distance between the deposit and the industrial centers is very great; the area would therefore not be able to compete with the manganese industry in Amapa, Urucum or Lafaiete, in the region of the iron industry quadrangle.

Mica. The problem here is the same as in the case of rock crystal. It has not been properly explored and prospected. It is very important however on the domestic market because it is used in electrical equipment, television, and electronics. Brazil is the second largest producer of raw mica in the world; we should really be exploiting it in a processed fashion, which would mean that we would earn more for our exports here. A great portion of the Brazilian output comes from the Araguaia-Tocantins region whose industrial development urgently requires attention from the federal government.

Graphite. The reserves of graphite in the region were estimated at 15 million tons. The most important graphite districts are in Peixe and Parana and the mineral reveals the following characteristics: fixed carbon -- more than 70%; ashes -- less than 2%; silica -- less than 0.5%.

Brazil imports a total of 3,140,000 dollars' worth each year and due to the high import prices we have the same threat to a rising domestic industry here as in other items. This means that we must definitely expand our use of the graphite in the Araguaia-Tocantins region which could immediately supply the Brazilian industry which is so short of this item here.

Rutile. Like mica and rock crystal, this is a prospecting product. During the war, the state of Goias was a great producer of rutile [titanium], not only for Brazilian industry but also for the United States. The rutile producer areas in the region are located in the townships of Pirenopolis and Corumba and, outside the basin, in the township of Ipameri which, during the last war, exported 500,000 tons.

Gold. The outlook for the utility of these deposits in economic terms, against the background of this region, can be quickly sketched as follows: we have information as to the existence of gold mineral in Cavalcante and Amaro Leite, in the vicinity of the Parana River; these however are not worth mining right now. Surveys made by F.J. Ferreira and Leonardos, show deposits in the following townships: Corumba, Pirenopolis, Jaragua, Niquelandia, Pilar, Amaro Leite and Arraias. Studies made by Gardier also mention deposits in the region of Dianopolis.

Diamonds. Diamonds are of great importance to Brazil not only because they are precious stones but because they are alos used industrially. The Araguaia-Tocantins region reveals the following outlook: diamonds have been prospected along the Tocantins River, in the vicinity of Itaguatins, at the waterfall of Lajeado, and in the region of Maraba. There are diamond deposits also in the aluvium [mud] of the Manuel Alves Grande and Sono rivers.

According to estimates made by the PROSPEC with respect to the lenses in the vicinity of Maraba, the gold here would exceed 250,000 carats; the government should therefore pay more attention to this area and devote more resources to prospecting; the government should participate in this effort in order to prevent the smuggling of diamonds in this township.

Radioactive Minerals. No search for radioactive minerals has been conducted in this region so far. However, deposits of uranium have been discovered in the vicinity of Porto Franco; this fact was mentioned in a presidential message in 1962.

Carbon Mineral. This is the very foundation for any nation's development and in the case of Brazil this is the greatest bottleneck of our heavy industry. The importance of coal in the Brazilian economy is becoming increasingly accentuated as the industrialization of the country progresses. So far, only three coal basins have been explored in Brazil; these are the basins of Parana, Rio Grande do Sul, and Santa Catarina. The first two are not suitable for heavy industry because they cannot be coked. Only the third contains coal that can be transformed into coke but production is only 1.4 million tons, which is about 40% of the Brazilian requirements. In 1962, alone, Brazil imported 13,626,000 dollars worth of coal, accounting for 60% of Brazilian consumption.

The Araguaia-Tocantins region and its vicinity contain various deposits of carbon mineral. In the basin of the Fresco River, large deposits of anthracite coal were discovered.

In 1957, six outcrops of carbon-containing material were found as part of the geological surveying of the Araguaia-Tocantins block by the PROSPEC; three are in the region of Carolina and three in the northern part of the Araguaia-Tocantins region. This formation reaches a depth of 414 meters near Carolina (Maranhao) where the carbon outcrops revealed a considerable content of uranium. Outcrops were also found in the township of Araguatins (Goias).

Verification of these deposits and the geological survey reports open up new prospects for the Brazilian economy in the heavy industry sector. An investigation program, outlining the deposits already found and spelling out the real possibilities for their industrial utilization, should be launched with the greatest possible urgency.

Vegetal Extraction

The vegetal extraction industry is important for two reasons: first of all it is in the area with the lowest index of advancement and, second, it reveals the best possible opportunities for rapid development and for the over-all progress of the entire region.

Mahogany, palm trees, and brazil nuts, as well as various types of timber, initially require an effort aimed at the organization of production and at the sale of the product; this of course also means the investment of the capital necessary for the development of the entire area. Let us look at some of the topics in this connection.

Mahogany. In a 1961 study made by the FAO for the SPVEA, we can find the conclusion to the effect that a forest reserve area should be created for the following purposes:

(a) preservation of mahogany forests in the northern part of the region;
(b) management of these reserves under modern administration;
(c) preparation of studies and experiments aimed at the revival of the mahogany forest for the purpose of promoting its growth.

We can find the following observations in a study made by the CIVAT:

(a) so far, we have no control or government supervision over the lumber industry;
(b) the small reserves that are left are being devastated now and there is no basic study of the economic potential represented here;
(c) there has been no check on the reforestation efforts, especially in view of the fact that the search for mahogany leads to the cutting of trails and roads into the forest and this in turn means that other types of

trees are being lost or wasted completely; these are trees that are of no immediate interest to the mahogany operators;

(d) we are wasting about 40% of the timber that could be prepared for industrial use, for both domestic purposes and for exports.

Brazil nuts. The Brazil nut is an important factor in regional development and we have a major producer center in Maraba which sells about 35% of the total Brazilian output or about 17,800 tons per year.

Here again we have bottlenecks which prevent the expansion of the output and which might be outlined as follows:

-- no minimum price in production zone;
-- Brazil nuts are not industrially processed in the producer zone itself;
-- no government measures or regulations relative to purchasing activities in the producer zone.

We must also point out that Maraba is isolated more or less here because of the inadequacies of the transportation system; it depends on river transportation for contact with Belem, via Imperatriz, in addition to the fact that it has no medical or hospital facilities, no education facilities, and public utilities.

Palm trees. The rational utilization of our palm tree resources, for domestic consumption and exports of various types of oil and vegetable fat would give the economy of the region a tremendous impetus and would create a highly profitable industrial center here.

From the palm nuts [almonds] we can extract oil that is used in cooking or as fuel and lubricant. The palm cake, as a by-product here, is extremely valuable in cattle feeding. The shell is used for making plates, brushes, flour, etc. It can also be turned into coke or it can be pressed and this gives us a fuel with a high calorific value.

The establishment of a palm products processing industry and a by-products industry in the producer region, considering the tremendous demand for vegetable oils and fats, both at home and abroad, would certainly point to some excellent possibilities and would appear to guarantee a high capital return.

Electric Power

For a country that has a power shortage and that wants to promote its over-all economy, the problem of the establishment of new power sources is not connected only with investments in power lines or the local consumer market. One must also consider the possibility of exporting this energy since it is a raw material that is needed in many finished products.

The principal hydroelectric power facilities of the region are as follows:

Itaboca	3 000 000 kW
Santa Isabel	1 750 000 kW
Alto Araguaia	40 000 kW
Santo Antônio	150 000 kW
Três Barras	400 000 kW
Mosquito	8 300 kW
Farinha	5 300 kW
Itapicuru	2 000 kW
Lajeadinho	1 500 kW
Lajeado	1 250 000 kW
São Félix	400 000 kW
Paranã	500 000 kW
Maranhão	200 000 kW

Anyone can plainly see that these power facilities will have many uses although they would require large sums of capital investments. Right now, only the construction of the Sao Felix power plant would appear to be justified as a result of the urgent need for the establishment of the nickel processing plant in the township of Niquelandia.

Not as large, although likewise of great economic importance, is the power plant at Farinha which is located in the far north of the basin; this power plant will supply the following consumer market: Carolina, Balsas, Imperatriz, Filadelfia, Itaguatins, Nazare, Piaca, Tocantinopolis, Porto Franco, Araguaiana and Babaculandia.

Transportation

This industry characterizes the entire economic and social complex of the Araguaia-Tocantins region.

The navigability of the Araguaia, which had its untiring protagonist in Couto de Magalhaes, even at that time was a natural instrument for the economic integration of the Brazilian Center-West.

It was the vision of this economic development which caused the Central Brazil Foundation to build the Tocantins Railroad (117 km) which supplemented the waterway, thus clearing the major obstacle of the Itaboca waterfall.

In the region of Araguaia-Tocantins, river navigation and aircraft, over the past several decades, were just about the only means of transportation.

To give the reader a better picture of the transportation situation in the Araguaia-Tocantins valleys, we will discuss each one of these means of transportation separately.

Waterways

Navigation on the Araguaia is still quite regular along such sections as Miracema do Norte to Estreito and from Imperatriz to Maraba; in other sections it is intermittent, such as from Maraba to Belem; but there is never

any qualitative control here. During the harvest season last year, about 50 boats were travelling back and forth along the Tocantins, mostly from Maraba and the vicinity; these boats had a capacity varying between 20-60 tons and all of them carried Brazil nuts.

Air Lines

Air line connections are becoming more and more stable here because this is the fastest means of passenger and light cargo transportation; meat, for instance, is delivered to the North.

The air line companies maintain regular line service to 26 out of the 177 towns in the area; the region is served by airports under the federal government as well as under state and municipal governments and even under private control.

Railroads

In the Araguaia-Tocantins region as such we have the Tocantins Railroad line which is 117 km long; it links Jatobal and Tucurui and was built to clear the rather serious navigation obstacle here, in the section of the lower Tocantins; this of course is the waterfall of Itaboca. This railroad line dates back to 1894 and reveals a number of technical inadequacies on the permanent way and on the curves where we have a radius of 80 m, and grades of as much 7.5%. A study was made of the possibility of extending the railroad all the way to the banks of the Xingu, which would make it possible to reach Cameta on the other side; this would have been an ideal way to transport mineral out of the valley.

Highways

The highway network is definitely being consolidated now. The construction of BR-14, supported by other highways (BR 7, 21, 24, 44a, 106) certainly makes this region a definite part of the national economy. The secondary connections will strengthen the north-south link even further; this link of course is the BR-14 highway.

It will be up to the highways to handle most of the transportation volume if we are to make proper use of the tremendous economic potential of these valleys; vegetable and mineral extraction as well as animal husbandry and agricultural products could certainly be carried most efficiently on the highways.

Action Taken by CIVAT During the 2 Years of Its Existence

Although the CIVAT did run into a number of problems, we must say that its accomplishments during the first year of its existence fully justified the motives that inspired the creation of this commission; this has been proved by the confidence expressed in it by other government agencies, by the governments of the member states, by the press, and by public opinion.

Although the organization had to struggle with a shortage of financial resources, there has been no decrease in the enthusiasm which has inspired the members of the commission in an effort to help in the economic recovery of a region inhabited by almost 2 million Brazilians.

The CIVAT thus carried out a number of major projects which had a high priority on them, including the following:

I. Collection of Secondary Data

(1) Collection of all weather and rainfall data in the region;
(2) Collection of all population and economic data in the region, covering population figures, area, townships, population density, agricultural and animal husbandry output, etc.
(3) Obtention, through SPVEA, of all aerial photographs, from the 13th parallel all the way to Belem, representing an investment of more than 10 million cruzeiros.

II. Topographic and Hydrographic Survey of the Tocantins River

-- Belem-Itaboca section with 435 km.

This is being handled on the basis of an agreement between the CIVAT, the DHN (Hydrography and Navigation Directorate of the Ministry of the Navy), and the CIBPU (Interstate Commission on the Basins of the Parana-Uruguai); the purpose of this program is the following:

-- Obtention of basic topographic and hydrographic as well as bathymetric data, as well as preliminary hydrological data from the lower estuary of the Tocantins River, with the figures necessary for the study and planning of improvement projects for the benefit of navigation.

A. Planned Projects

(a) Planimetry -- a polygon was opened up from a first-order geodetic bench mark; precision corresponding to third-order triangulation;
(b) Altimetry -- parallel to this a trigonometric survey will be conducted, accompanying the general polygon;
(c) Establishment of limnimetric posts and lines;
(d) Bathymetry service, tied-in with the previously mentioned polygon.

-- Work carried out during 1963 under the abovementioned agreement.

All of the planimetry and altimetry work under this agreement has been completed.

-- Details:

(a) Collection of general information on the project;

(b) Preliminary reconnaissance, coverage of sections to be studied, observations of astronomical data, observations of river tides, determination of geographic coordinates, establishment of principal and secondary hydrographic network with:

1. Coordinated observations;
2. Azimuth observations;
3. Angle observations;
4. Distance measurements;
5. Aerial photogrammetry flights;
6. Establishment of tide recording stations;
7. Determination of sounding support points [sounding stations];
8. Determination of support bases for aerial photogrammetry;
9. Processing of sounding charts;
10. Processing of flight charts.

III. Topographic and Hydrographic Survey of the Waterfall of Itaboca

Purpose: Collection of data indispensable for the construction of this gigantic project which is intended for the improvement of energy, navigation, and irrigation.

This project has already been terminated and includes the following:

(1) Planimetry and altimetry of five overlapping polygons;
(2) Survey of five transversal polygons;
(3) Establishment of river gauge markers.

IV. Hydrographic and Geology Project

The studies will be carried out together with the French hydrological mission and will include the following:

(1) Detailed reconnaissance of the Araguaia-Tocantins basin;
(2) Implementation of the CIVAT hydrology program for 1964, including various phases;
(3) Hydrological studies along the Upper Araguaia, including:

A. Detailed reconnaissance of the basin of the Upper Araguaia, covering an area of 4,000 sq km;
B. Establishment of a rain gauge network;
C. Studies of the surface, including the vegetation, relief, geology, and the other physical characteristics of the basin;
D. Establishment of a river gauge station for permanent control;
E. Preliminary study on the waterfall of the Upper Araguaia;
F. Continuous maintenance of rain gauge and river gauge measurement stations.

V. Projects Submitted by CIVAT

A number of projects worked out by the technical team of the CIVAT, completed during 1963, have been presented; they include the following:

(1) CIVAT working program for 1963; on a priority basis, this program was intended to work out a system for the collection and evaluation of data, parallel to the studies concerning projects of an immediate nature, including the following topics:

A. Hydrology;
B. Navigation;
C. Energy utilization studies;
D. Economic and social research studies.

Out of this CIVAT work program for fiscal year 1963, which was budgeted at 331,000 Cr$, only the following were completed due to a shortage of personnel:

(a) In the Hydrology Sector:

1. Establishment of markers and limnometers on the Upper Araguaia;
2. Establishment of the rain gauge network along the Upper Araguaia.

(b) Navigation:

1. Topographical and hydrographical survey by the DHN, as part of the agreement with the CIVAT and the CIBPU, along the Lower Tocantins.

(c) Energy utilization studies:

1. Survey of the Itaboca waterfall and the waterfall on the Upper Araguaia.

(d) Economic and social research studies:

1. Survey, collection, and processing of population data from secondary sources;
2. Social and economic research plans for the entire basin which could not be carried out because of a shortage of personnel;
3. Work done by the technical team, entitled "The Araguaia-Tocatins Basin -- Axis of National Economic Integration," presented to the federal government and to the member states, containing a faithful report on the economic reality of the basin and its importance in the national context;
4. Work presented to the meeting of governors at Cuiaba, prepared by the technical team, spelling out a number of considerations of high importance for the Araguaia-Tocantins basin;

5. Studies and surveys on the following problems on a national scale:

A -- Construction of the railroad all the way to Peixe (economic justification);

B -- Mineral wealth of the basin, with special emphasis on the possibilities of nickel, carbon mineral, rock crystal, amianthus, graphite, and the influence of these items on the Brazilian import balance;

C -- Study of vegetation resources, including mahogany, palm trees, and Brazil nuts;

D -- Work on the education problem in the Araguaia-Tocantins basin;

E -- Work on the public health problem in the Araguaia-Tocantins basin.

FIGURE APPENDIX

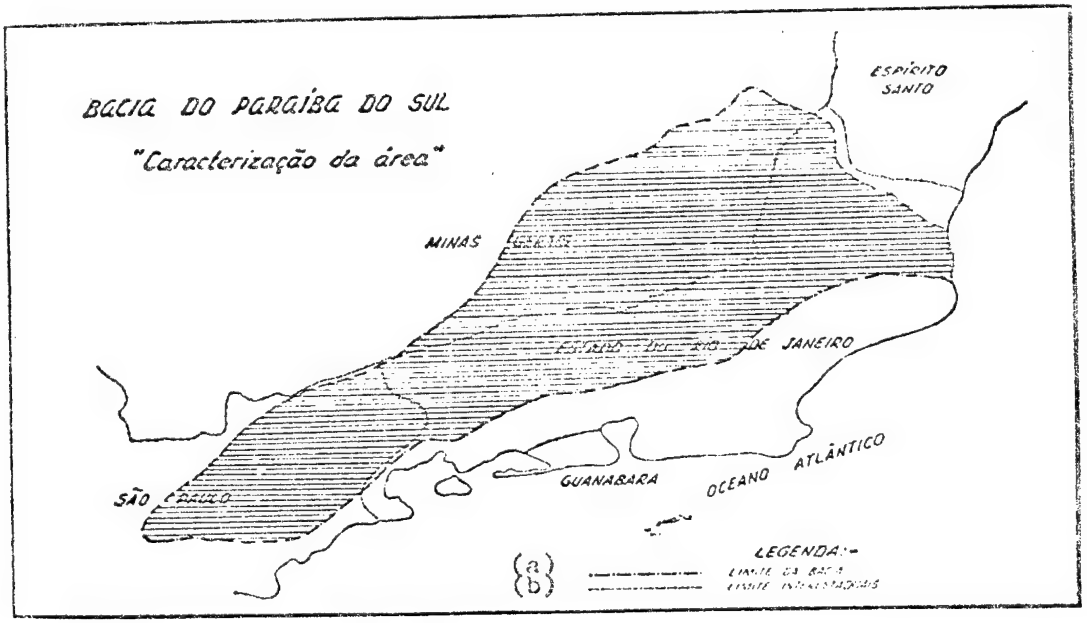


Figure 1. Basin of the Southern Paraiba, sketch of area.
Legend: a -- boundary of basin; b -- state boundary.

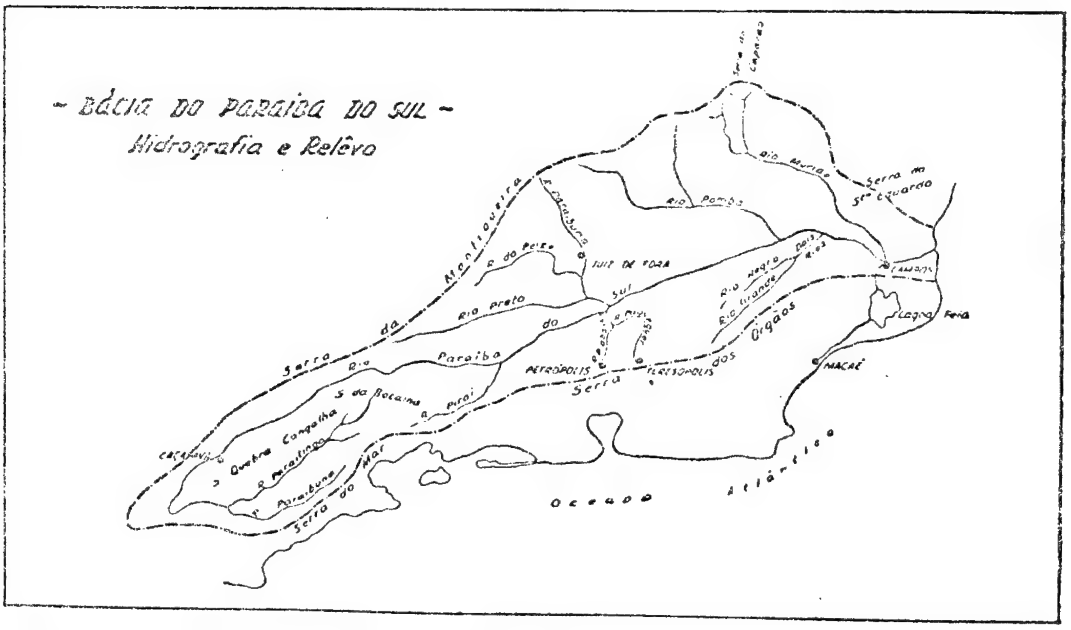


Figure 2. Basin of the Southern Paraiba, hydrography and relief.

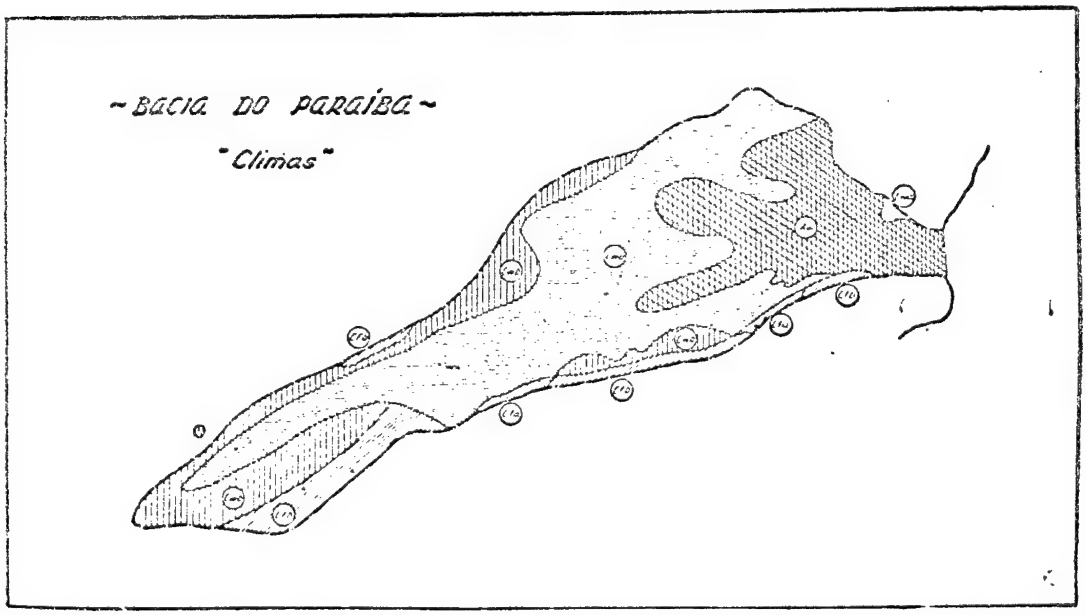


Figure 3. Basin of the Paraiba, weather.

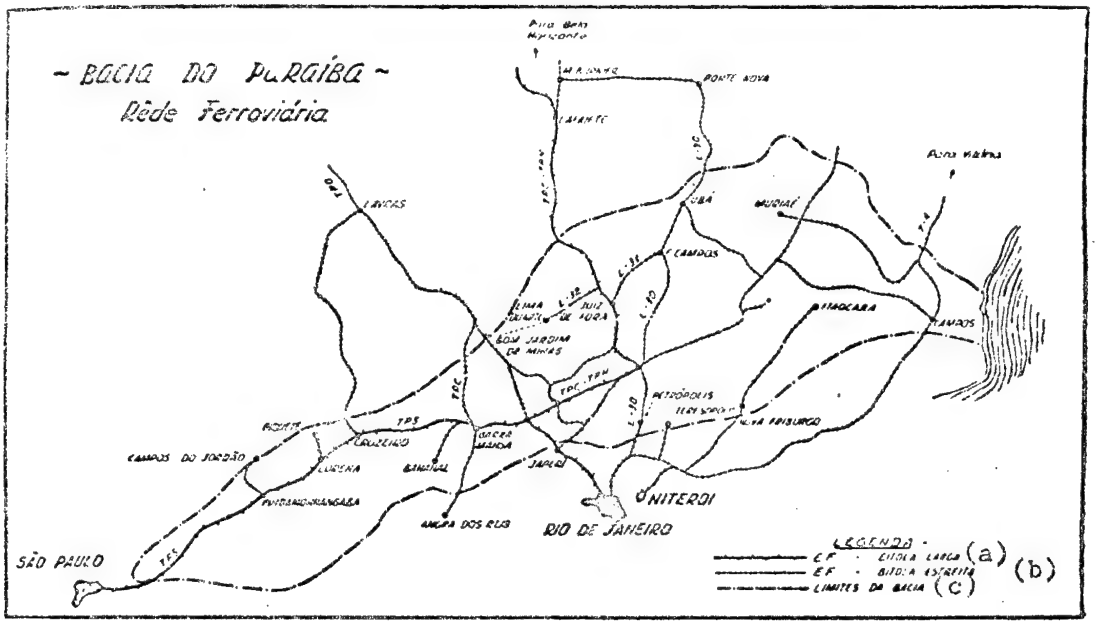


Figure 4. Basin of the Paraiba, railroad network.
Legend: a -- wide-gauge; b -- narrow-gauge; c -- boundaries of basin.

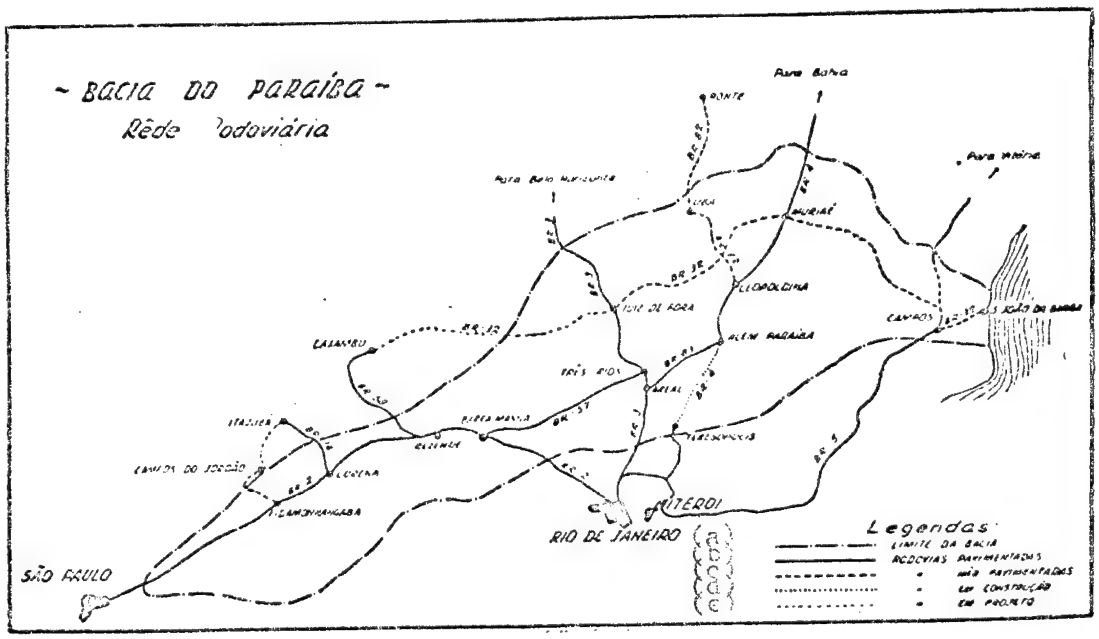


Figure 5. Paraiba basin, highway network.
Legend: a -- boundary of basin; b -- paved highways; c -- unpaved highways;
d -- highways under construction; e -- highways projected.

Rice -- Staple Food of Brazil (pp 440-444) Pericles Santos Cruz

Rice is one of the most important cereals of the world; rice growing conditions are good in all states of Brazil. Since it is a cereal poor in nitrogen, it is nutritive and easy to digest and this is why it is highly recommended for inclusion in the human diet. We find protein, starch, and mineral substances in any of the rice varieties but the "white" variety, which is commercially more valuable [more expensive], contains less nitrogen than the "yellow" rice. The albumin percentage varies, depending upon the rice variety. One of the ways in which we can utilize the greater or smaller proportion of nitrogen-containing substances is the process of boiling. The rice variety that requires longer boiling time contains more nitrogen. The ease with which it can be produced in hot and humid climates is paralleled by its natural distribution and adoption by the rural populations all over the world.

No matter which way we travel through Brazil, we are bound to run into a rice plantation. Sometimes it might come in the form of efficient rice field plantations and at other times we find simple, rather rudimentary rice paddies. Because of its wide use at meal times, because of the low price and the ease with which it can be obtained, rice has become the staple food of half of the world's population. In addition to those areas where it is widely grown, starting with the Far East and moving through Europe and into the Western hemisphere, we might mention such other great rice producers today as China, Japan, Indochina, the Philippines, Malaysia, the United States, Italy, Spain, and Brazil. All of these are countries with great population densities and there rice has become a basic foodstuff.

According to some writers, rice has been cultivated in China and India for more than 4,000 years; its spread to other countries, however, was rather gradual and slow. It was reported to have been cultivated in Babylon about 400 BC but it was not introduced into Syria until the 6th century AD. It took almost another century before Egypt adopted it as a cultivated plant and later on it spread to Europe. It finally reached Spain through the Arabs and during the 15th century it was introduced into Italy where it became very popular. One century afterward, more specifically, in 1647, it was introduced in the United States where it flourished only for a short time afterward, under the impetus of Thomas Smith.

By and large, however, we cannot say that rice is specifically eastern in origin, except for one or the other "varieties." Some researchers have said, in their reports, that this cereal has been in existence as a native plant in Brazil or that it at least was introduced here a short time before [European] discovery of Brazil. Cabral encountered it as he came to our shores. Of course, the technique and cultivation methods were imported by various peoples. Official records indicate that the first attempts at rice cultivation in Brazil were made in 1745 with excellent results; however, notes by Brother Gaspar da Madre de Deus support evidence to the effect that rice cultivation existed in Sao Vicente around 1550-1557.

That particular author re-asserts the assumption that rice is a native Brazilian plant, on the basis of the fact that our Indians know about it and used it. In Cronica Geral do Brasil (General History of Brazil), we have a passage in which Melo de Morais tells us that, in 1590, Cristovao de Barros,

at that time governor of Bahia, on a trip through the territory of Sergipe (which was still being explored for the first time), stopped for lunch with a local tribe and was served a dish of boiled rice and venison by one of the Indian chiefs. Although our data on rice cultivation in Brazil are rather scarce, we can document the fact that it is a rather old crop here; considering its great economic value as a staple food for our people and as a raw material for some of our industries, we should certainly regret the fact that many of our rice farmers are still using old-fashioned methods for rice cultivation.

Rice belongs to the Graminaceae family, Glumi-florae series; it is a part of the Oryzae group in which Oryza includes all of the cultivated species. The Zizania and Zizianiopsis species are known as "wild rice" [savage rice] (the aborigines of America used it in preparing their meals). It is a graminea which grows annually, a real cereal cultivated through the production of grains used in the human diet.

The plant has fibrous roots in a fasciculated system and these roots extend more in a horizontal direction than in depth. This is one of the types of cereal that grow much more above the surface of the soil. The adult plant reveals two types of adventitial roots, which shoot off the trunk, and the permanent roots which always shoot off the crown. The trunk [culm] is always cylindrical and hollow and it may be straight or bent. In a non-irrigated field, rice develops more permanent roots whereas the presence of water stimulates the formation of the adventitial roots.

Depending upon the variety and the soil treatment, every clump or cluster may have as many as 15 culms. Here is a description of the cycle of development:

From planting to germination -- 6 days; from germination to straightening -- 20 days; from straightening to blossoming -- 60 days; from blossoming to fructification -- 30 days; and from fructification to maturation -- 12 days; this gives us about 129 days from planting to harvest and the cylce may be longer or shorter depending upon the variety. The varieties of the longer vegetative cycle are the longer-grained varieties and here the cycle may take as much as 150 days; among these varieties we have the "needle" variety, golden variety, the Carolina variety, the black-point variety, the golden hairy type, the silver variety, "matao" variety, the Honduras and Iguape varieties.

The yellow, blue-rose, "chatao," "cambraia," "cacho-de-ouro," and "caiana" are "medium" varieties whereas the Japanese, "chiador," "catete," "buriti," and "amarelinho," and "saquarema" are of the "short" varieties.

The seeds are planted in little holes in the ground that are 6 cm deep, on the average; the interval between holes is 25-30 cm; we have 8-10 grains per hole. The average seed expenditure is 85 kg of grains per ha (10,000 sq m). If the terrain is more or less level, we get more uniform irrigation. At the beginning of maturation the water begins to disappear, the soil therefore can dry out during the period prior to the harvest. Any delay in the harvest may lead to serious damage.

Rice is used as industrial raw material in making beer, cheap brandy, alcohol, vinegar, acetone, butyric acid, flour, and other products. The leaves and culms are used in making hats and mats; some countries use the pulp in making paper and in Brazil it is used widely for feeding animals; this means that rice is used completely and that it is the most economical of all of the crops.

By way of information on rice production, the production statistics service has published some figures in the Anuario Estatistico do Brasil (Statistical Yearbook of Brazil), 1964, for the 3-year period of 1961-1963:

(a) ANO	(b) Produção (tonelada)	(c) Valor (Cr$)
1961	5 [illegible] 177	[illegible]
1962	5 [illegible] 854	[illegible]
1963	5 [illegible] 045	[illegible]

Legend: a -- year; b -- output (tons); c -- value (Cr$).

The average output was 1,633 kg/ha.

The five major producers were: Rio Grande do Sul, Sao Paulo, Minas Gerais, Goias and Maranhao; the five producers at the bottom of the list were Guanabara, Amapa, Distrito Federal, Roraima, and Amazonas.

We believe, however, that a three-year output of approximately 17 million tons (16,688,876 tons for the 3-year period of 1961-1963) is just a beginning for a population of almost 90 million inhabitants and that we must therefore develop this crop tremendously by using new techniques and by providing more effective financial assistance.

Sources of Information

1. Farmers in the Forest Region, State of Rio de Janeiro.

2. Rural University -- kilometer marker 47 on the old Rio--Sao Paulo Highway.

3. Jose Marinho Lopes -- Juiz de Fora, Minas Gerais.

4. Ti-Long-Ly, Paracambi, State of Rio de Janeiro.

Bibliography

1. Cultura do Arroz (Rice Cultivation), (M.A.) Prof Americo Miranda Ludolf.

2. Historia de um Cereal (History of a Cereal Crop), Pericles Santos Cruz.

3. Anuario Estatistico do Brasil, IBGE.

FIGURE APPENDIX

Figure 1. Rice field in the township of Goiania, state of Goias. Photo by CNG.

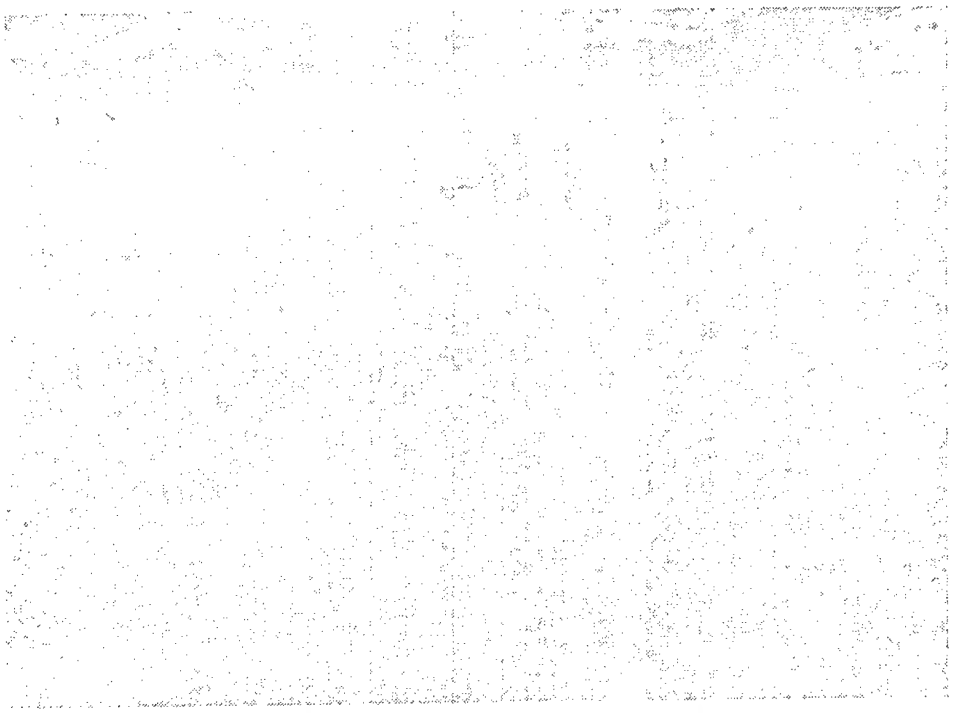


Figure 2. Rice cultivation in the township of Sao Sebastiao do Alto. In the background, farmers are shown cleaning the cultivated area. Photo by CNG.

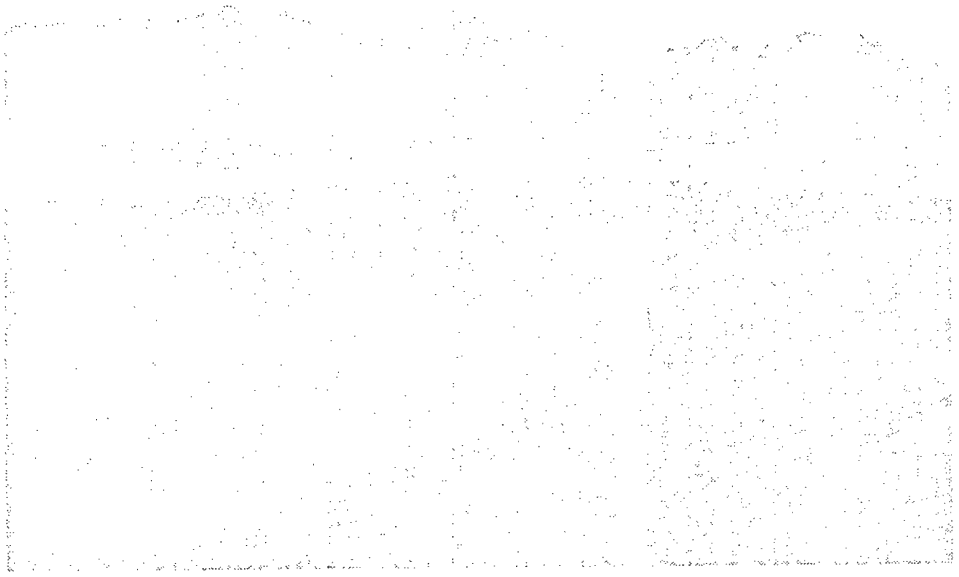


Figure 3. Flood plain planted with rice in an area called "Vargem," near the township of Amarante, in the state of Piaui. Photo by CNG.

Figure 4. Swamp planted with rice in township of Itaocara, state of Rio de Janeiro; farmers are shown transplanting rice. Photo by CNG.

Figure 5. Rice plantation in township of Sao Miguel, Rio Grande do Sul. Photo by CNG.

Contribution to the Regional Geographic Terminology (Physical Geography) (pp 471-474)

Antonio Campos e Silva

(Referring to the region of Rio Grande do Norte.)

ABA -- Flanks of a mountain range or an elevation, slope.

ACHIRO -- Shore of lagoon or lake; boundary of field in clearing, piece of land, etc.

AGRESTE -- Transition vegetation between rain forests and scrub woodland. Dardano de Andrade Lima considers the "agreste" to be one of the many forms assumed by the scrub woodland. The term also includes the area occupied by man.

AGUADA -- Portions of water which advance inland, along the rivers or lagoons; narrow stretches of lagoon (Apodi).

ALAGAMAR -- See Lagamar.

ALTO -- Elevation of about several dozen meters; dikes of pegmatite which, due to differential erosion, stand out above the level surfaces of the Serido.

ARACATI -- Northeast trade winds which received that name from the western strip in the state of Rio Grande do Norte.

ARISCO -- Sandy soil, poor in clay; may result from on the spot decomposition of crystalline rocks poor in ferromagnesian elements or from the washing of detritus in the coluvium; the term is also extended to the vegetation encountered here.

ARUA -- Name given to the countless genuses of molluscs, many of which belong to Planorbidae family, responsible for carrying schistosomiasis; at Governador Dix-Sept Rosado, fossil molluscs belonging to the genus of Tylostoma have been found.

BARRA -- Narrow river mouth; mouth of river in broader sense; string of low clouds.

BAIXA -- Any kind of relative depression, Col, in region of Joao Camara the term is applied sometimes to the dolinas.

BANQUETA -- Small sandbar used in local delimitation of diamond beds or gold fields, to separate the areas of the various prospectors (Serido).

BARREIRA -- Marine cliff; any abrupt natural drop or any artificial drop in the clayey rock.

BARREIRO -- Small dam intended primarily for animal watering; accumulation of water in depressions with clayey bottom; place where clay is extracted for ceramics or brick making.

BARRETA -- Cut in roof permitting entry or exit of water to the inland section, with oscillations of tide.

BARRO -- Clay; mixture of clay and sand, silt, or both.

BATATAO -- Will-o'-the-wisp; common term used especially along the litoral in the vicinity of the mangroves where the phenomenon is considered a mirage, also called "pai do mangue."

BICA -- Spring, generally used for water supply or bathing.

BOCA -- Confluence or mouth of river; limit of vegetation formations: "boca da mata" [edge of forest].

BOLANDEIRA -- Halo formed around the moon or the sun, taken as a sign of rainfall; old part of [sugar] mill, consisting of a big wooden wheel moved by animal power.

BREJO -- Humid place in the middle of the scrub woodland; strictly speaking, we can consider here only the "brejo" in Rio Grande do Norte or Apodi, situated in Pedra das Abelhas (Felipe Guerra); this feature is due to the development of a river fed with water coming up from the cuesta of Apodi. In some mountain ranges (Martins, Portalegre) there are a number of areas that could be considered brejo.

CABECA DE CARNEIRO -- Species of coral, used in Piranji in making lime; possibly belongs to the genus Millepora.

CABECO -- Rounded-relief terrain feature, gentle, about 100 m high.

CACIMBA -- Well drilled in land where water table is near surface; these cacimbas generally are rather shallow; this is a little-used synonym for "tanque" (see below).

CAMBOA -- Arm of the ocean in sedimentary accumulations of dead estuaries.

CAMINHO -- System of orientation used by fishermen on the basis of the terrain features along the coast that are visible from the open sea (Natal).

CAPOEIRA -- Area of devastated vegetation [second-growth scrub forest]; section of vegetation originally devastated and now in process of recomposition [restoration].

CARRASCO -- Scrub woodland vegetation with trees and brush; this, in reality, is not a typical "caatinga" since it reveals a foristic composition which differs very little from the latter or which might even be the same; here we have a skeleton soil which corresponds to the previously mentioned vegetation type; in Natal the term is applied to a type of compacted tableland [low tableland]; this is the origin of the name popularly used for the district of Governador Dix-Sept Rosado.

CARREIRA D'AGUA -- Any kind of marine current; river current.

CARREIRO -- Milky way.

CASCAO -- Type of rather impure chalk from the deposits at Governador Dix-Sept Rosado.

CHA -- Level or gently rolling surface of crystalline and crystallophilene terrain; corresponds to the erosion "glacis" of the Pliocenic levelling surface; in the mountain ranges: level top.

CHAPADA -- In the case of the high, steep-sided tablelands of Apodi, the Verde mountain range, and others, this corresponds to the reverse of a "cuesta"; in mountain ranges with sedimentary strata, this is used in referring to the flattened top; in a broader sense, it includes any level surface covering a large area.

CHUMBINHO -- Pisoliths of hematite found in the soil of the Apodi high, steep-sided tableland.

CHUMBO DE CARRASCO -- See Chumbinho; term used in the region of Lajes.

CORISCO -- Beam; flash of lightning; falling star.

COSTA -- Along the beaches near the estuaries, this term is applied to the definitely marine shoreline, differentiating it from the situation in the estuary.

CORREGO -- Little stream; corrupted version: Corgo.

CORTA -- Stop flowing (in case of river).

ESPERDICIO -- Type of chalk (Governador Dix-Sept Rosado).

ESTREITO -- River or lagoon narrows [strangulation].

FUNDURA -- Depth.

FORMIGUEIRO -- Small tronconic construction in the mouth of the "formigueiros" [anthill].

FURNA -- Cavern, grotto.

JACARE -- Type of chalk (Governador Dix-Sept Rosado).

JUREMAL -- Association of "juremas" (Mimosa sp.).

LAGAMAR -- Small cove flooded and emptied with the flow of the tides; swamp.

LAGOA -- Term applied to one of the countless lagoons formed by the eolic barrier along the litoral.

LAJEIRO -- Outcropping of bare rock, more or less level; bed of rocks.

LAMA -- Silt; clay supersaturated with water.

LEVADA -- Little valley; natural or artificial irrigation facility.

LOMBADA -- Land between streams, convex top, elongated form (Caraubas).

MALHADA -- Area of animal pastures; comes up in many place names: Malhada Vermelha, Malhada do Rio, Malhada Grande.

MANGUE -- Halophile vegetation community in the drowned estuaries and drowned river mouths; term applied, by way of extension, to the edapho-ecological complex of the area; various species of vegetables among which we might single out the representatives of the genuses Aviconnia, Laguncularia and Rhizophora.

MASSAPE -- Mud-clay alluvium in some rivers along the eastern strip of Rio Grande do Norte; type of yellowish sandy clay, very plastic when saturated with water.

MATA -- Megathermic rain forest; the frontiersmen also apply this term to the scrub woodland with trees.

MOITA -- Agglomeration of low vegetables, more or less isolated.

MORRO -- Small terrain elevation; dunes along the shore.

NEVE -- Dense fog or heavy mist; low layers of clouds; condensations at the tops of the mountain ranges; the frontiersman uses the following expression in this connection: "heavy fog in the mountains, rain down in the valley."

OCA -- Clayey-sandy sediment, rich in iron oxide, giving it an ochre color.

OLHEIRO -- See Olho-d'Agua.

OLHO-D'AGUA -- Spring.

OITEIRO -- Mountain; isolated low hill with undefined form.

PAREDE -- No qualifying description; constitutes edge of continental shelf.

PAREDE FUNDA -- Portion of platform which extends from dry wall all the way up to the deep river bank.

PAREDE SECA -- Portion of continental shelf from beach all the way to a depth of 35 fathoms.

PARRACHO -- Overhanging cliff.

PAUL -- Peat; peat-containing soil, generally formed along the rivers where the dunes fill up the mouth.

PEDRA -- Any rock; roundish pebble; as place name, generally refers to "Inselberg" or other terrain features of modest size.

PEDRA DE CORISCO -- Pre-historic stone tool; this name is used on the basis of popular tradition because these instruments were presumed to be the result of a flash of inspiration [flash of lightning].

PEDRA DE SINO -- Phenolith; rock producing a metallic sound when struck with a hammer or steel tool.

PERAU -- Continental slope (Natal).

PICARRA -- Nodular lateritic concretions, frequently found in Barreiras formation; in many cases, related to erosion levels.

PINGA -- Small spring; term frequently used in areas where we have karst phenomena (Apodi, for example).

PORAO -- Deepest point of rivers, lagoons, dams, etc.

PONTA -- Small prolongation of continent advancing into ocean; in Rio Grande do Norte these are primarily due to the concentrations of laterites which, because of their greater resistance to the erosion of the ocean, have been spared differential erosion.

PRATEADO -- Type of soil rich in lime which moves through the alluvium; we found this term only in Jacoca, Ceara-Mirim.

RATINHO -- Type of coral used in making lime (Piranji).

REVANCHE -- Dry portion of wall of dam between water level and crown of dam.

RIACHO -- Small water course, periodic in the interior and perennial along the shore; in some parts of the semi-arid interior these are synonymous with the oueds.

SACO -- Elongated and elliptical formation along the edges of the mountain ranges; small cavity.

SALAO -- Clayey or sandy-clayey soil in flood plains where large quantities of sodium and magnesium salts, and mostly fluorides accumulate.

SALGADO -- Sandy terrain still containing organic material and clay, occasionally flooded by high tide; found in dead estuaries and rivers; synynom for salao.

SALITRE -- Sodium or magnesium chloride found in saline soils; sometimes synonymous with "salao"; corrupted form: salitro.

SANGRIA -- Flow rate along dam when dam reservoir is full.

SERIDO -- Type of scrub woodland with prairie appearance; the vegetation here has caused some authors to consider it a type of community different from the "caatinga" [scrub woodland]; the term was applied to the region where the abovementioned community occurs.

SERRA -- Hectometric terrain feature which may be a monadnock or an Inselberg of rather large dimensions; term applied, in the southern part of the cuesta of Apodi, to the opposite of the cuesta; sometimes confused with cuesta.

SERROTE -- Modest terrain elevation, generally bare or very rocky.

SUMIDOURO -- Kerst chimney.

TABATINGA -- Clay which, when baked, assumes a white coloration; clay rich in indications of diatomaceous earth at the bottom of lagoons and lakes.

TABULEIRO -- Vegetation community of the savanna type, generally found in the Tertiary terrain of the Barreiras formation; level surface of glacis of the Barreiras; poor soil, essentially siliceous; found in rather infertile land between streams; also applied to stretches of level terrain [low tableland].

TANQUE -- Rounded, elliptical, or elongated excavation in granitic or gneissic bosses, sometimes rich in Quaternary mammal fossils.

TARUGO -- Artificial dike, erected on top of "salgados" and mangrove swamps, in plant nurseries, salt marshes, etc.

TAUA -- Red clay, very plastic, revealing shades ranging from blood

red to canary yellow.

VARZEA -- Major river bed [flood plain]; alluvial deposits extending from the valley bottom to the base of the slopes; some of them are cut into more heavily by the rivers during the floods.

VAZANTE -- Major middle bed of a stream, used heavily when water level drops; posterior portion of dam, submerged in water during winter and lieft uncovered in summer.

VIRACAO -- Breeze, gentle wind.

Wooded Sand Bar at Jacarepagua (pp 538-546) unsigned

(Taken from the work entitled Flores da Restinga (Flowers of the Wooded Sand Bar), prepared by the following experts from the Biological Reserve of the State of Guanabara: H.E. Strang, Secretary of the Biological Reserve Commission, in charge of the research center; Prof A. Castellanos, Director of Research; C.M. Chaves, biological draftsman; F. Atala, botanist; H.F. Martins, ecologist; A.F. Coimbra F.°, naturalist; I.L. Soares, draftsman; T.T. de Campos, draftsman.)

The wooded sand bar or spit of Jacarepagua, located between the ocean and the level foothills of the mountains, constitutes -- with its beaches, dunes, lagoons, and vegetation -- one of the most beautiful and astonishing natural regions of the State of Rio de Janeiro. Quite abruptly we leave the rugged, densely forest-covered border country here and we enter the plain of white sands with low and shrub vegetation, amid the lagoons of Marapendi, Jacarepagua, Camorim and Tijuca, which snake their way along between the swamps and marshes.

Far off in the distance, outlined along the beach by Sernambetiba Avenue, we can see a vast green tapestry spreading before us, with rolling fields and lagoons. Quite paradoxically however, this also makes for a rather monotonous picture.

Unfortunately, the area has been touched by man, in spite of the efforts of the government to transform this region into a [public] park. Many if not the majority of the animal species which used to live here have disappeared as a result of the ruthless and indiscriminant hunting. The flora, for its part, is rich in examples used in modern gardening, such as Nery melon cactus, seashore dropseed, philodendrons and bromelias, and so on. Some of the species are already in the phase of extinction. Fires, still quite frequent today, complete this rather desolate picture in a region that used to be considered richer in vegetation than any other in the world. Parallel to this, people from various backgrounds and with various purposes in mind, some well-intentioned, others more or less surreptitious, have been settling down along the lagoons and have built a number of houses here and there, improperly occupying the terrain. People very often go looking for shells at the bottom of the lagoons and this has brought about all kinds of disturbances and visible damage to nature.

In spite of this rather brief sketch, we can say that this part of the State of Guanabara is very seriously threatened; this action on the part of man here is liable to mar the landscape aspects of the beach, of the sand bar and the mangrove forests, with all of its magnificent biological complex.

Geographic Location and General Remarks

The plain or depression of Jacarepagua, consisting of definitely small-grained sandy soils, extends from Mt Boa Vista to Mt Joatinga; it is

generally laid out like a semi-circle, penetrated in the Northwest by the massif of Pedra Branca.

It covers an area of approximately 140 sq km of which 13 sq km are taken up by the lagoons of Marapendi, Camorim, Jacarepagua and Tijuca and 14 sq km by green vegetation land earmarked for public parks. Most of this plain extends for a distance of 23 km along an East-West direction; the maximum North-South distance is 8 km. The beach, including the section between Barra da Tijuca and Pontal de Sernambetiba, is 18 km.

The natural boundaries of the region, starting in the West, and taking the Atlantic, to the South, as reference, are the following: the Geral de Guaratiba mountain range, the Pedra Branca massif, the Engenho Velho mountain range, and the massif of Tijuca, with its arms, the Pretos Forros mountain range and the Tijuca mountain range, as such.

The water mass of the lagoons thus covers a surface of 13,636,000 sq m, distributed as follows: Marapendi, 4,576,000 sq m; the combined lagoons of Jacarepagua--Camorim--Tijuca, 8,884,000 sq m; and, the so-called Lagoinha lagoon with 176,000 sq m; the latter holds sweet water and is in the midst of a process of natural sedimentation (lowland built up by silt-laden water). Lagoinha currently gets water from the Cortado channel and drains into the Marapendi lagoon, through the Taxas channel. Marapendi originally also consisted of potable sweet water, a fact that is documented by the ancient settlement sites here.

Although we do not yet have any specific studies on the climate of this depression, the area in question belongs to a number of climatological categories, depending upon the particular author who drew up the categorization. Thus Koppen thought that it was of the "Af" type or the ever-humid tropical climate, with a temperature of more than 18° C during the coldest months and with rainfall distributed throughout the entire year.

The depression of Jacarepagua serves as a drainage basin for the slope of the Tijuca mountain range which is opposite Guanabara. Near Tanhanga(or Itanhanga) rock, at the beginning of the lagoon of Tijuca, we come to the Cachoeira River which comes down from the caves of Agassiz and which captures the water from the remaining swamp forests of Tijuca. Further on, in the lagoon of Camorim, we have coming in the waters from the das Pedras River, the Anil River, the Fundo Creek, and other smaller water bodies. Pavuna Creek and Pavuninha River also flow into the lagoon of Jacarepagua.

With the exception of Marapendi, the three lagoons mentioned above in reality constitute a single mass of water and their names vary only from one region to the next. Marapendi, situated between the strip of beach and the abovementioned lagoons, is connected on the one side with the Tijuca lagoon, along the bar by the same name, near Gigoia Island, by means of an artificial channel. At the other end it links up with Lagoinha, as we have seen earlier.

The generally rather plain and uniform appearance of this part of the

country here and there reveals some rather odd terrain features, such as Itauna rock, opposite the last third of the Marapendi lagoon, taking the form of a rather high island that breaks up the level appearance of the plain. To the far south of the sand bar, looking like an advanced outpost in the ocean, we have Point Sernambetiba which, at low tide, is connected to the beach by a sand and gravel bar. Likewise interesting because of their isolated location in the middle of a rather vast flatland area, we have Mts Urubu, Portela, Amorim, and Rangel, reproducing, on firm ground, the chain of oceanic islands that are arranged in isolation or in small groups in the middle of the ocean.

History

The sand bar of Jacarepagua, a traditional redoubt of the Correa de Sa, is a treasure chest of Rio de Janeiro history. Ever since the middle of the 17th century, when it was broken up into two large properties, there have been numerous sugar mills, cattle ranches, and cassava plantations flourishing here under the beneficent sponsorship of the Benedictine Fathers. Today, with the diversification of customs and the change in times, the area still preserves some of the old features of the past that has nevertheless turned into a region with a modern characteristic of its own -- something which is partly due to the isolation resulting from the rather difficult topography. This is the zone of the "Rio de Janeiro interior," in the poetic words of Magalhaes Correa, where simple habits and very primitive farming activities of the Brazilian interior can be observed in all of their spontaneity, side by side with modern progress. Magalhaes Correa also gave us a very lively and suggestive picture of the population living here rather isolated; these people have, to this very day, been living off the land, with a psychology going back many centuries and with traditions that are almost subconscious. Here we find the farmers, the cane cutters, the fishermen, the dam maintenance men, the banana plantation workers, the sheep and goat herders; all of them give us the picture of a peaceful rural countryside, with farms, hunting in the lagoon areas, burros hauling fire wood, the abundant flora and fauna of the transition vegetation between the tropical forest and the scrub woodland -- all of them today more seriously damaged by man than ever before.

But all of this is changing in our time. The picture which the famous Rio de Janeiro writer and artist drew for us are today like characters out of the past, reviving the old way of life, here and there, at Cafunda, Taquara, Cabungui, or Covanca, with the memories of days long past.

Originally this tremendous "far west" of Rio de Janeiro, as we said before, was made up of two land grants in old colonial Brazil. One of them, it seems, was obtained in 1624 by Salvador Correa de Sa e Benevides, governor general of Rio de Janeiro. The other was obtained by a relative of his, Goncalo Correa de Sa, shortly afterward. The first of these grants was bordered to the East by the bar of Tijuca, the present-day urban area of Jacarepagua and a portion of Taquara; like the land grant of Goncala Correa de Sa, it was bordered on the West by the Pavuna River and then by a straight line running to the ocean, thus including the lagoons of Camorim, Tijuca, and

a part of the lagoon of Marapendi.

The history of the land grants of Correa de Sa, which were extended all the way to Campos, along the shoreline of Rio de Janeiro, is full of political intrigues and trickery involving the Court in Lisbon and the vice-kingdom of Brazil. For more than 2 centuries, these two land grants dominated an entire period in our colonial history, primarily in the Rio de Janeiro region of Asseca, full of the same impetus and tenacity of the ancestral founders and defenders of the city of Rio de Janeiro. In Jacarepagua the situation continued rather peacefully. The land grant of Salvador Correa de Sa was sold to the Serpa Pinto family by his heirs; it constituted the old Fazenda da Restinga ranch which in 1920 was sold to Geraldo Rocha. The latter, together with Carlos Kiel, gave the ranch in payment to the Sao Paulo-Rio Grande Company which later on sold it in small pieces of land. One part, bought by Eugenio Lefevre, made up the so-called "Tijucamar" development land; the other one was sold to Euvaldo Lodi and it was called "Jardim Oceanico" [Ocean Garden]; the third part was sold to Diedrich, de Giorgi, MacGregory, and others.

The land grant of Goncalo Correa de Sa was inherited by Miss Vitoria Correa de Sa, his daughter. Before she passed away, Miss Vitoria deeded all of her possessions to the Monastery of Saint Benedictine on 30 January 1667: "I declare that all of the land from the Pavuna River to the sea and running along the coast line to Guaratiba, with all of the mountains and fields and sand bars and lagoons and rivers are mine and that I inherited all of this land from my parents and my uncles. I also do declare that I do appoint as my universal heirs for all of the property named herein and hereafter, belonging to me or to be inherited by me, the Monastery of Saint Benedict of the Invocation of Our Lady of Montesserrate, in this city of Rio de Janeiro."

When Miss Vitoria passed away on 26 August 1667, all of this property became the property of the Monastery of Saint Benedict whose monks, having come from Bahia, settled down here in Rio in 1589.

For the next 224 years the land was in the hands of the Benedictine monks who introduced advanced farming methods here. During that period of time, large ranches flourished at Camorim, Vargem Grande, and Vargem Pequena, belonging to the Brotherhood of Our Lady of Loreto de Jacarepagua whose tricentenary we celebrate on 6 March 1961.

In 1760, the Marquis of Pombal, in Lisbon, ordered the expulsion of the Jesuits; the Benedictine monks at that time were also persecuted. The attorneys of the Viscount of Asseca, whose land grant bordered on the above-mentioned land, and who was in Portugal, challenged the validity of the last will and testament of Miss Vitoria Correa de Sa. But the monks were able to hold on to their property especially when the Viscount called off his lawyers. On 29 September 1871, 17 years before the Golden Law, the Benedictine monks took the initiative in liberating their slaves. As a result of major difficulties and because the Order could not continue maintaining the property, the land was sold on 5 January 1891 to the Engenho Central de Jacarepagua Company. During the following month, the company sold the property to the real estate credit bank for 1,000 contos de reis.

Miscellaneous Factors

In 1777 the Viceroy, the Marquis of Lavradio, fearing an attack from a Spanish squadron upon Rio, ordered that all the beaches be fortified, especially in the region of the depression of Jacarepagua. "Thus," wrote Augusto Fausto de Souza, in Fortificacoes do Brasil (Fortifications in Brazil), "two batteries were placed on the sand bar of the lagoon and another two batteries, called Itapua and Pontal, were put on the beach nearby at Sernambetiba; three batteries were put in the defiles of Engenho Novo and on the Mateus mountain range. Two batteries were put on the sand spit of Tijuca and Alto do Boa Vista; all of these batteries covered the access ways to the city and would thus be able to fire on any Spanish forces that might land between Point Gavea and the sand bar of Guaratiba."

The Taquara ranch, today a historical shrine, in colonial times was sold to Correa de Sa e Benevides by Commander Serpa Pinto.

The Camorim ranch begins the old Caixa d'Agua road which, in colonial times, was paved with big paving stones near the chapel of Sao Goncalo Amarante which was built in 1925. Sao Goncalo Amaranto [monastery] owns the Camorim ranch.

The region is therefore very interesting from the historical viewpoint; featuring an assortment of mountain ranges, forests, isolated hills, plains, lagoons, and marshes, it reveals the history of the land, with all of the long-lasting simple habits of these planin people. But as the big city spreads further and further, the area of Jacarepagua is increasingly losing its original characteristics and is changing under the irresistible force of progress.

Geology

The term "restinga" [wooded sand bar or spit along a coast] has various meanings in Brazil. In the Geological-Geomorphological Dictionary of Teixeira Guerra, the term "restinga" or "flora litoranea" [litoral strip] is described as a long-drawn out island, or strip or tongue deposited parallel to the shoreline as a result of the constructive and destructive dynamism of the ocean water. These deposits are made with the help of points or capes that usually bar a series of small lagoons. In the particular case of the depression of Jacarepagua, we have some typical examples of the lagoons that can usually be found here.

We do not want to go into the technical details here and we do not want to discuss the various theories as to the origin of these sand bars or spits; let us merely review rather briefly some of the factors that are of objective interest from the regional geology viewpoint.

On the sand bar of Jacarepagua, as on those of the general type that can be found along the southern shoreline of the country from Bahia all the way to Rio Grande do Sul, we find a large sand plain which extends from the

foothills of the mountains down to the ocean beach. Its characteristic feature might be compared to a long and gentle arc, arranged parallel to the beach. In the interior, a short distance from the ocean, physical and mechanical agents which have been at work for many thousands of years have created many small lagoons.

The ends of the sand bar and possibly its foundation are made up of ancient rocks dating back to the Archean. The layer of sand, consisting of ocean deposits and material brought in by the rivers and streams, is of rather recent age, in other words, the Quaternary.

According to the classical scheme prepared by Alberto Ribeiro Lamego, the mechanism of formation involved here is determined by three factors:

-- the presence of the smooth tide;
-- the presence of a shoreline current which continually runs into the continental shelf;
-- and finally, an abundance of sand, continually moved back and forth by circular water currents.

According to the same writer, the phenomenon took place in the following fashion: the shoreline current, running into the waters in the cove, produced a movement in the form of a closed circle. This leads to the formation of a secondary circuit which re-mixes and deposits the sand deposited earlier in the cove. At the level of the point or the cape, which marks the the boundary of the cove, the action of the waves is less intensive and we consequently find here the successive deposit of material carried on by a current which is tangential to the cove.

Other authors, however, including Ruellan, emphasize the action of waves running in a direction oblique to the litoral and think that this is responsible for the formation of the sand bar. Those waves are directed by more constant winds, always accompanied by storms. Since the currents here have a rather limited speed, the work is done essentially by the waves. This theory is in direct opposition to the theory of Lamego.

Flora

Looking at it over-all, the vegetation of the sand bar appears like a grassland vegetation which, in a not always homogeneous but nevertheless characteristic development, penetrates into the interior from the beaches; the vegetation here includes rather short grass and we have a number of trees and underbrush strips at a number of isolated capes and points. As we said before, it looks very monotonous and rather poor. It does not reveal the luxury and exuberance of the hydrophile forests along the slopes in the background but when we take a closer look we find a number of plants and color variations. One noteworthy fact in the flower vegetation of the sand bar is the color which is always rather vivid and varied, in contrast to what happens in the forest areas, where the flowery vegetation varies very little.

Here we find the ridacea Neomarica ("butterfly"), far from the roadside, with its pointed leaves and its white blossoms, slightly budding along the dorsal side, sprinkled in the center by brown and violet grooves, intermingled with yellow; next we have Epidendrum ("the orchid of the sand bar") with its rather small and pink flowers in the form of pretty, elongated flower arrangements; we also have the following here: the gum-containing plant of the genus Clusia ("beach onion") with its white flowers and the red streak down the middle; the convalvulacea Ipomoea, with its large reddish flowers and another variety of this genus with the yellowish flowers; the goodeniacea Scaevola plumieri, with its white-yellowish crown and its wrinkled petals, standing out against the surrounding area by virtue of its wine-colored flowers; marcgraviacea Norantea brasiliensis which appears in a compact formation just before we get to the lagoon strip, blood-red in color. But of course we also find the Melocereus fernambucensis and Cereus Arrabidae cacti here, growing in the sand along the beach, with their white flowers and their red fruit; the Melocactus violaceus, growing out of the sand in the sand bar of Itapeba, like a black cotton seed covered with long thorns; this plant is very popular in gardening because of its rather curious appearance.

Extremely abundant, in the strip extending along the beach and all the way to the edge of the lagoons, is the "beach palm" or "guriri," also called Diplothemium maritimum rather conspicuous because of the absence of the aerial stalk. It grows in vast and dense communities, sometimes pure and sometimes intermingled with other plants, dominating the dunes with its characteristic appearance. The small corn-colored flowers group profusely along the slopes of the dunes and constitute the favored habitat of hymenoptera insects.

In this low vegetation zone we must also mention the Canavalia obtusifolia, passifloracea Passiflora mucronata, and Centropogon and others.

The flora, primarily a result of the climate and the nature of the geographic relief, here is generally speaking quite open and low, with the exception of the formations found along the edges of the lagoons and on the capes; here the vegetation is somewhat higher, more intricate, and harder to reach.

A number of authors, including Alceo Magnanini, who concentrated on this region, in particular, have emphasized the action of the ocean in shaping the beach and have indicated that this is a cyclic action, with constructive and destructive phases occurring in a periodic and alternating fashion. This produces a parallel advance and withdrawal of the vegetation. During the constructive action of the ocean, the vegetation develops fully and reaches more advanced stages in terms of forms and numbers of representatives. However, this process is interrupted with the destructive wave cycle. Over-all, looking at the vegetation zones along the beaches in Sernambetiba, Magnanini emphasizes the presence of three separate strips, running roughly parallel to the ocean, starting from the wave lines on the beaches and heading inland. The first strip represents the beach without any visible signs of superior vegetation, constantly washed by the waves. The second strip looks slightly grassy, quite narrow in places and somewhat wider

in other places. Finally we have the third strip which is characterized by the presence of "guriri" (palm trees).

Another cactacea and miscellaneous bromeliacea also appear scattered here and there, without any particular system; these are found here among a wide variety of blossoming and ornamental plants.

Around the lagoons, especially around the lagoon of Parapendi, where we have no salt content at all in the water or just very little salt, we do not have any mangroves as a result and we therefore find Typha latifolia var. dominguensis or, commonly called the "cattail, along with rushes and ferns of the Acrostichum genus and other hygrophile plants.

In this brief sketch of the flora of the sand bar, we must not fail to mention the mangrove forest or mangrove swamp formations which appear in areas with a high salt content, along the edges of the lagoons. The mangroves constitute a fruit and tree vegetation type, compact in itself, with a complex of respiratory roots and aerial roots. The aerial roots are used for support and the respiratory roots take care of the biological needs of the plant which cannot be taken care of by the soil alone. The layer in which this vegetation takes hold is generally rather deep, black, loose, and rich in bacteria and it is the seat of active processes of decomposition. This fact is brought out by the constant bubbling of gases to the surface and by the formation of a surface film which isolates the water from the air. Countless crustaceans, including the land crab and the beach crab, are quite abundant here. The ground may be flooded constantly or only at high tide; this phenomenon can be observed in the Tijuca lagoon, in the vicinity of the sand bar. The typical plants in this formation are those of the genus Rhizophora, Avicennia, and Laguncularia, the first of these belonging to the Rhizophoracea family, the second to the verbenacea, and the last to the combretacea.

Further toward the interior, in the perimeter strip of the lagoons, we come to a marshy zone with a rather dense and intricate vegetation and a black soil; here we find Equisetum, a rather odd plant because of its typical ramification, with ciliary crowns, starting from each of the nodes of the herbaceous trunk; here we can also find the Blechnum fern, the Philodendrum, the Tillandsia bromeliacea, growing on top of the other trees, including Cyperus, Hibiscus, etc.

We find a rather interesting formation at Lagoinha. Since the water is sweet here and because a layer of humus has been deposited along the edges, we run into a small strip of hygrophile forest here with a tree vegetation intermingled with some rather dense and viridescent epiphytes, quite in contrast to the low and open vegetation of the surrounding areas.

On the dunes of Itapeba we find many representatives of the following families: myrthacea (Brazil cherry, strawberries), apocinacea, malvacea, anonacea, (araticum); anacardiacea (beach cashews), melpighacea, leguminosa, acantacea, verbenacea, polygalacea, guttifera, cactacea, bromeliacea, sapindacea, lauracea, etc.

Fauna

In the not too distant past, the lowlands of Jacarepagua were inhabited by a very rich fauna. This richness was reflected in all zoological groups, and this of course was quite in keeping with the wealth of the flora, also. However, the constant advance of man and the resultant destruction of the natural habitat completely upset the balance of the fauna of the region. This imbalance can also be noticed in the flora, of course. Many species of mammals, such as the jaguar, the spotted leopard-cat, the white-lipped peccary, white-collared peccary, great anteater, capuchin monkey, etc, as well as such birds as the snipe, stork, Picazuro pidgeon, comb duck, etc, are now extinct. Other species which still survive are very rare, such as the sloth, water cavy, coati, otter, guan, partridge, snipe, yellow-headed turkey vulture and bat falcon, which could be restored only as a result of a very laborious resettlement process.

In spite of all of the damage caused by indiscriminate hunting and fishing, which has led to the disappearance or thinning-out of the ranks of numerous representatives, we can still find the following with a certain degree of abundance: alligator, tegu lizard, spotted cavy, capuchin monkey, forest (wild) dog, tayra, saki monkey, cavy, hare-like rodent, tulpacoti dove, dove, rail, crake, jacana, large gull, miscellaneous herons, masked duck, white-faced tree duck, fish hawk, cormorant, kingfisher, swift, tiger heron, caracara, pygmy owl and carrion hawk, etc.

One spectacle that is worth noting here, for example, is represented by the groups of white herons posted along the edges of the lagoons or the jacana and the crakes as they skim the surface of the water in search of fish, along with small grebes. Now and then we can observe the graceful oyster-catcher birds which are famous for their migrations; they leave the North American continent and fly all the way down to Patagonia. The most frequent among these is the small Azara collared plover which regularly takes up its station along the edges of the lagoons and the beach where it lives on beetles.

The list of indigenous species in this area would be too long for us to complete here; but this indicates that some of the places in this region could certainly be designated as natural wild life refuge areas. As a matter of fact, it would be very easy to restore a tremendous natural zoo here, such as it used to exist long ago; today this area is nothing more than a rather pale memory of the exuberant life that used to prevail here in the past.

FIGURE APPENDIX

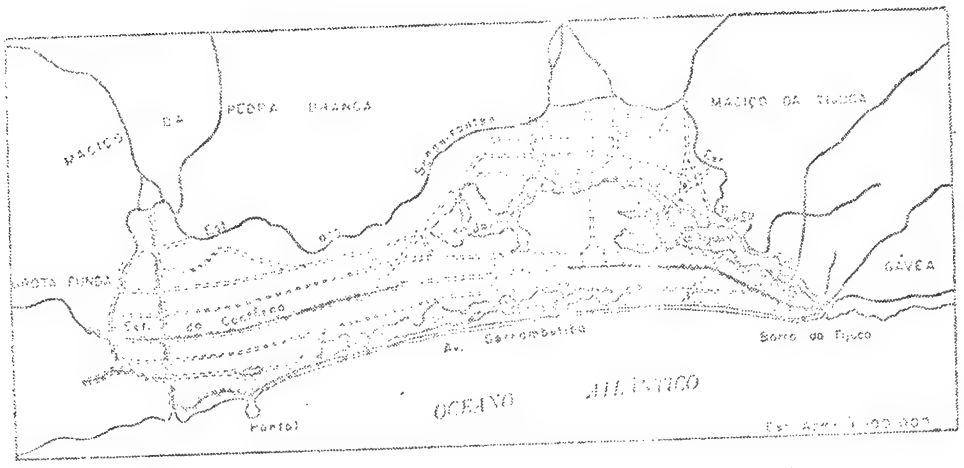


Figure 1. The sand bar of Jacarepagua is located between the Atlantic Ocean and the Guaratiba and Tijuca mountain ranges. This is a vast plain, deposited by the constructive and destructive dynamism of the ocean water; it extends from the foothills of the mountains all the way to the beach. In the interior, not far from the ocean, the work of the physical and mechanical agents has partitioned off a number of small lagoons, some of which, such as Lagoinha, are being filled up with silt. Over-all, this region rather abruptly projects from the rugged and forest-covered border along the ocean home and runs into the white sand plain which is covered with low and shrub vegetation, intermingled with swamps and marshes; this is one of the most beautiful natural regions of Guanabara.

Figure 2. The vegetation of the sand bar does not always reveal a homogeneous development but it is characteristic nevertheless. From the mud along the beach to the interior we have a succession of gramineæ, a species of small size, covering small patches of land. The "beach palm" or "guriri" is extremely abundant in the border strip extending from the mud along the beaches, which is occasionally washed by the ocean water, all the way to the edge of the lagoons.

Figure 3. Because of the weather and the nature of the geographic relief, the flora of the sand bar is generally open and low, with the exception of the marshy sections along the edges of the lagoons and the coppices; as the terrain rises, the vegetation becomes taller, more intricate, and harder to reach.

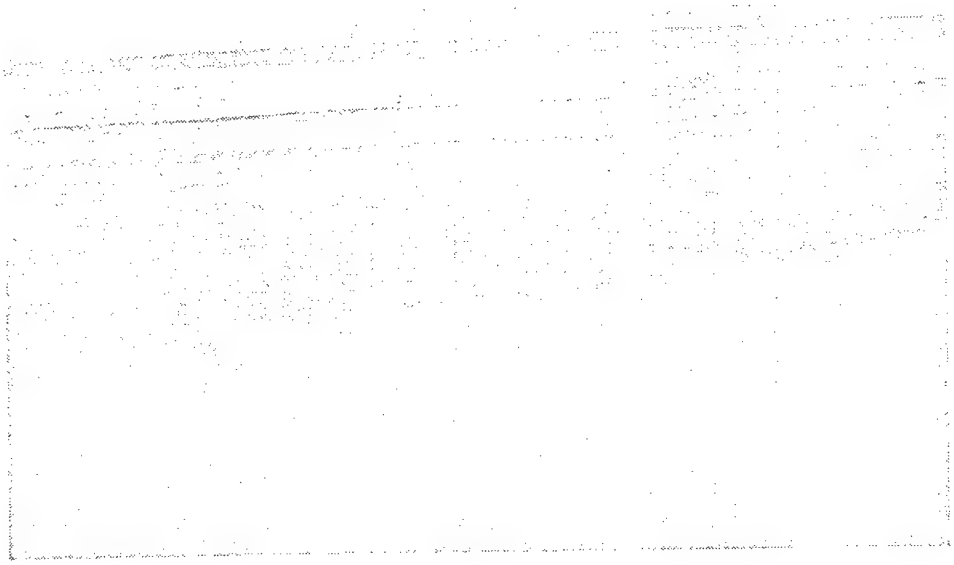


Figure 4. Formations of mangroves appear in areas with a high salt content, along the edges of the lagoon. The mangrove swamps constitute a fruit-bearing and tree-containing vegetation which reveals a complex of aerial and respiratory roots. Numerous crustaceans can be found here (crabs, etc). The ground is either constantly flooded or only at high tide; this phenomenon can be observed in the lagoon of Tijuca, near the bar.

Occurrence of Mammals Belonging to the Original Fauna in Southeastern Brazil (pp 626-641)

Estanislau Kostka Pinto da Silveira, Assistant zoologist of the CPFCN

I. Regulation or Conservation of Fauna in Biological Reserves

(1) Hunting shall be prohibited within the boundaries of the biological reserves [national parks, forests, wild life refuge], and it shall also be regulated outside of the boundaries of these national parks, by the state, in order to defend our fauna.

(2) Licenses shall be issued only to government naturalists and persons assigned or attached to the biological reserves and to similar research centers.

(3) Hunting shall be prohibited in the forests of our mangrove swamps so as to offer a refuge to our fauna.

(4) Hunting of animals considered useful because they destroy insects and other harmful animals; these useful animals include anteaters, armadillos, large badger-like skunks, owls, seriemas, snake-eating laughing hawk, etc.

(5) Killing pregnant female animals or female animals accompanied by their offspring, nesting birds, spawning fish, and any immature or stray animals may definitely not be killed.

Note: We can successfully restore and conserve the fauna of a given area only if we observe these rules.

Some of the animals which used to populate the regions of southeastern Brazil, several hundred years ago, can still be found here; sometimes they are frequent and sometimes they are rare; others were driven out of the various regions, such as the northern part of Sao Paulo, Minas Gerais, and Espirito Santo; they are therefore considered extinct as far as the fauna of the particular area is concerned.

This annihilation was due to the inexorable advance of civilization, the inevitable increase in noises, the general movement of people, the pollution of the air by exhaust gases, the clearing of land for industrial areas, indiscriminate and secret hunting, the decrease of the flora which of course constitutes the food basis for the fauna and so on.

In this report we shall not cover the entire group of mammals found here because this would be too long; besides, some of the species have a rather doubtful distribution area; the species marked with an asterisk (*) are those which are still found in the region of Guanabara and in the adjacent regions, regardless of whether they are frequent or rare.

The geographic area covered by this report includes the land in the northeastern part of Sao Paulo, the southern half of Minas Gerais and Espirito Santo, as well as the area extending to the Atlantic Ocean, in addition to the inland waters, such as bays, coves, etc. The continental terrain

features involved here, as well as the islands of Paqueta, Governador, Rasa, Comprida, Cagarras, etc, are the Mar, Mantiqueira, Caparao mountain ranges and others, the river depressions and the sand bars along the ocean shore, the valleys of the Paraiba do Sul, Macae, Itabapoana, Doce rivers, etc, and the lagoons of Marapendi, Camorim, Jacarepagua, Feia, Araruama, Marica, Imboacica, etc.

II. Physiographic Aspects of the Southeastern Part of Brazil

The most rugged portion of the Brazilian geomorphological landscape, undoubtedly, is the vast region of the southeast which stands out quite clearly in the eastern mass of the continent. This geographic region is characterized by many aspects which are interconnected, such as, the highlands, the massifs, the humid tropical climate which prevails in the higher reaches and which predominates almost throughout the area, as well as the Atlantic forest.

The principal stretch in the southeastern part of Brazil is the highland section irrigated and drained by the Paraiba do Sul River and its tributaries, plus the Mantiqueira and Bocaina mountain ranges, the plateau of southern Minas Gerais, the forest zone, the highland of the territory of the state of Espirito Santo, extending, more or less, to the southern part of the Doce River valley; the mountain ranges in the zone of Sao Paulo-Santos, of Canastra, and the far south of Espinhaco; the Mar mountain range, the massifs of Carioca and Bangu-Jacarepagua and the rugged region extending all the way to Belo Horizonte, to the north-northwest. This area covers 280,000 sq km and one of its highest points is Mt Agulhas Negras, in the massif of Itatiaia, with an elevation of 2,787 m above sea level.

In its folds and scarps, we find a luxuriant tropical rain forest which extends up to about 1,800 m; above that elevation level, as the temperature drops, we note that the forest is heavily reduced both in size and in number of botanical species; here we also find peat bogs, clusters of trees, and also the start of the subsequently predominant field vegetation. As we reach the top, at elevations of more than 2,500 m, we can observe a grass vegetation consisting here only of some fields and typical shrub plants, gradually mixing with and changing into a rocky, high-elevation desert vegetation.

Most of the fauna thus lives below the rain forest line along the slopes of the massif, at elevations of less than 1,800 m.

The climate in this mountain block is a tropical, humid, high-altitude climate, with rainy summers and dry winters. The relative humidity is always high and there is frequent and abundant precipitation; this is quite characteristic of the scarps along the ocean shore and, in the interior, we find that this situation changes into a dry season during the winter. (Information based on Ab'Saber, A.N., and Bernardes, N. "Valley of the Paraiba, Mantiqueira Mountain Range, and Surroundings of Sao Paulo," 18th International Congress of Geography, CNG, 1958, Rio de Janeiro.)

In order to enable the fauna to remain in a certain region, we must have a number of basic requirements and factors including food, weather, topography, etc. We know that vegetarian animals stay in an area because of

the food offered them by the vegetation in the area and this of course brings us to the flora of the region which would thus have to be more or less rich in fodder and fruit-bearing species; once the environment enables vegetarian animals to live there, we can gradually observe the development of carnivorous animals, alongside with vegetarian animals; these carnivorous animals are attracted by the abundance of these other animals and by the ease with which the prey can be captured. This leads to the formation of a food and nourishment chain and the fauna thus remains preserved in the region.

In some of our fields and highlands here we find certain plants which constitute a natural pasture ground for the herbivorous wild animals, along with certain fruit trees and bushes for the omnivorous and fruit-eating animals which inhabit these sections of the country and which must be preserved and defended against a variety of destructive agents, such as natural fire or man-made fire, the clearing of forests and shrubbery for lumber, etc.

All of the ecological environments, such as the forests, the plains or the mountains, the fields, the prairies, the river banks and the shores of the lagoons as well as the ocean beaches, etc, have their own characteristic fauna which varies with the elevation, the weather, and the modifying factors such as the terrain, and on the basis of the particular type of fauna, that is to say, litoral or inland fauna. Among the fauna of the dense forest we find many primates such as: saki monkey, spider monkey, spider monkey, capuchin monkey, marmoset, howling monkey or bearded howler, tayra, coati, jaguar, agouti, hedgehog or small porcupine, water cavy, white-lipped peccary, more rarely, white-collared peccary, tapir, armadillo, brocket or red deer, giant armadillo, hedgehogs, squirrels, etc.

In the woodland savanna and in the fields, once again, we find tayra, water cavy, white-collared peccary, tapir, large badger-like skunks, the spotted cavy, many kinds of deer, such as the brocket or red deer, etc.; great anteater, little anteater, opossum, mouse opossum, hare-like rodent, scarlet ibis, fox-dog, wolf, cougar, jaguar, etc.

In the rivers and lagoons we find otters and giant river otters, rats, and water opossum along the banks; we also find tapirs and water cavy. Since all of these animals drink water, we find that at certain times of the day many animals gather along the rivers and lagoons in search of this precious liquid.

In the zone of transition between the forest and the prairie, we find representatives of the forest, prairie, and field fauna, more or less intermingled; these boundary zones have been given the ecological name "transition zone."

The continent today actually has a rather poor mammal fauna but we had in the past a very rich and highly varied mammal fauna, not only because of the wealth of species but also because of the tremendous size of some of them; South America has always had a geologically native fauna of its own, originating in the so-called "archaic fauna" of the Lower Tertiary which takes us back approximately 80 million years.

III —

ORDER: *CETACEA*

2 Bôto ..... + *Sotalia guianensis* (Van Beneden 1863) — *Delphinidae* +

3 Bôto ou toninha ..... — *Tursiops truncatus* (Montagu 1821) — *Delphinidae* +

4 Bôto-pilôto ..... + *Globicephala melas* (Traill 1809) — *Delphinidae* +

5 Delfim, golfinho ou marsuíno ....: + *Delphinus delphis* Lin. 1758 — *Delphinidae* +

6 Orca ..... *Orcinus orca* (Lin. 1758) — *Delphinidae*

7 Orca ..... *Pseudorca crassidens* (Owen 1846) — *Delphinidae*

8 Baleia-de-Cuvier ..... + *Ziphius cavirostris* Cuvier 1823 — *Ziphiidae* +

9 Cachalote ..... + *Physeter catodon* Lin. 1758 — *Physeteridae* +

10 Cachalote-anão ..... *Kogia breviceps* (Blainville 1838) — *Physeteridae*

11 Baleia-real ..... *Eubalaena australis* (Desmoulins 1822) — *Balaenidae*

12 Rorqual-anão ..... + *Balaenoptera acutorostrata* (Lacépède 1804) + — *Balaenopteridae* +

13 Rorqual ..... *Balaenoptera borealis* Lesson 1828 — *Baldenopleridae*

14 Rorqual "Fin-back" ..... + *Balaenoptera physalus* (Lin. 1758) — *Balaenopteridae* +

15 Rorqual azul ..... *Balaenoptera musculus* (Lin. 1758) — *Balaenopteridae*

16 Rorqual ou jubarte ..... + *Megaptera novaeangliae* (Borowski 1781) — *Balaenopteridae* +

ORDE *PERISSODACTYLA*

17 Anta prêta ou tapiara-pixuna (2) *Tapirus t. terrestris* (Lin. 1758) — *Tapiridae*

ORDER: *ARTIODACTYLA*

18 Caitetu ou pecari-colera (3) + *Tayassu t. tajacu* (Lin. 1758) — *Tayassuidae* +

19 Queixada ou pecari-açu ..... *Tayassu a. albirostris* (Illiger 1811) — *Tayassuidae*

20 Veado-bororó ..... + *Mazama rufina nana* Hensel 1872 — *Cervidae* +

21 Veado-catingueiro (4) *Mazama g. gouazoubira* (Fischer 1814) — *Cervidae*

ORDER: *LAGOMORPHA*

22 Tapiti ou coelho-do-mato ..... + *Sylvilagus brasiliensis tapetillus* Thomas 1913 — *Leporidae* +

ORDEM: *EDENTATA*

23 Tamanduá-bandeira (5) *Myrmecophaga t. tridacyla* Lin. 1758 — *Myrmecophagidae*

24 Tamanduá-mirim (5-A) + *Tamandua t. tetradactyla* (Lin. 1758) — *Myrmecophagidae* +

25 Preguiça-de-bentinho (6) + *Bradypus infuscatus brasiliensis* Blainville 1840 — *Bradypodidae*

26 Preguiça-de-coleira ..... *Bradypus torquatus* Illiger 1811 — *Bradypodidae*

27 Tatu-peba ..... + *Euphractus sexcinctus setosus* (Wied 1826) — *Dasypodidae* +

28 Tatu-galinha ..... + *Dasypus n. novencinctus* Lin. 1758 — *Dasypodidae* +

29 Tatu-pindoba ..... + *Cabassous unicinctus* (Lin. 1758) — *Dasypodidae* +

30 Tatu-rabo mole ..... + *Cabassous hispidus* (Burmeister 1854) — *Dasypodidae* +

31 Tatu-açu ou canastra (7) *Priodontes giganteus* (Geoffroy 1803) — *Dasypodidae*

ORDER: *PRIMATA*

32 Mico ou sagui ..... *Callithrix flaviceps* (Thomas 1903) — *Callithricidae*

32 Mico ou sagui ..... + *Callithrix aurita coelestis* (M. Ribeiro 1824) — *Callithricidae* +

33 Mico-cabeça branca ..... *Callithrix geoffroyi* (Humboldt 1812) — *Callithricidae*

34 Mico-leão (8) + *Leontideus rosalia* (Lin. 1766) — *Callithricidae* +

35 Guariba ruivo (9) + *Alouatta guariba clamitans* Cabrera 1940 — *Cebidae* +

35 Guariba ruivo ..... *Alouatta g. guariba* (Humboldt 1812) — *Cebidae*

36 Sauá ..... + *Callicebus personatus brunello* Thomas 1913 — *Cebidae* +

36 Sauá ..... *Callicebus p. personatus* (Geoffroy 1812) — *Cebidae*

37 Sauá-testa preta ..... *Callicebus nigrifrons* (Spix 1823) — *Cebidae*

38 Muriqui ou macaco-aranha ..... + *Brachyteles arachnoides* (Geoffroy 1806) — *Cebidae* +

39 Macaco-prego (10) + *Cebus apella nigritus* (Goldfuss 1809) — *Cebidae* +

ORDER: *CARNIVORA*

40 Onça suçuarana (11) *Felis concolor greeni* Nelson et-Golman 1931 — *Felidae*

41 Jaguatirica (12) + *Felis pardalis mitis* F. Cuvier 1820 — *Felidae* +

42 Gato-do-mato ..... + *Felis wi wieddi* Schinz 1821 — *Felidae* +

43 Gato-do-mato ..... + *Felis tigrina guttula* Hensel 1872 — *Felidae* +

44 Jaguarundi ..... + *Felis yagouaroundi eyra* Fischer 1814 — *Felidae* +

45 Jaguar ou onça pintada (13) + *Panthera o. onça* (Lin. 1758) — *Felidae* +

46 Cachorro-do-mato ou lobato (14) + *Cerdocyon thous azarae* (Wied 1824) — *Canidae* +

47 Guaxinim (15) + *Procyon cancrivorus nigripes* Mivart 1886 — *Procyonidae* +

48 Quati pardo (16) + *Nasua nasua solitaria* Schinz 1823 — *Procyonidae* +

49 Jupará (17) *Potos flavus nocturnus* (Wied 1826) — *Procyonidae*

50 Lontra ..... + *Lutra c. enudris* F. Cuvier 1823 — *Mustelidae* +

51 Ariranha ..... *Pteronura b. brasiliensis* (Gmelin 1788) — *Mustelidae*

52 Irara (18) + *Eira b. barbara* (Lin. 1758) — *Mustelidae* +

53 Furão pequeno ..... + *Galictis cuja furax* (Thomas 1907) — *Mustelidae* +

54 Furão grande ..... + *Galictis vittata brasiliensis* (Thunberg 1820) — *Mustelidae* +

55 Maritacaca ou cangambá (19) — *Conepatus chinga suffocans* (Illiger 1811) — *Mustelidae*

56 Elefante-marinho (20) + *Mirounga leonina* (Lin. 1758) — *Phocidae* +

57 Lôbo-marinho ..... + *Otaria flavescens* (Shaw 1800) — *Otariidae* +

ORDER: *RODENTIA*

58 Serelepe ou caxinguelê ..... + *Sciurus aestuans ingrami* Thomas 1901 — *Sciuridae* +

59 Cururuá ..... *Echimys blainvillei medius* (Thomas 1909) — *Echimyidae*

60 "Rato-espinhoso" ..... *Echimys brasiliensis* Waterhouse 1848 — *Echimydae*

60 "Rato-espinhoso" ..... *Echimys nigrispinus* (Wagner 1842) — *Echimyidae*

60 "Rato-espinhoso" ..... + *Proechimys dimidiatus* (Gunther 1875) — *Echimyidae* +

60 "Rato-espinhoso" ..... *Proechimys iheringi bonafidei* Moojen 1948 — *Echimyidae*

60 "Rato-espinhoso" ..... *Proechimys i. iheringi* Thomas 1911 — *Ehimydae*

61 Guirá-do-rió (21) + *Euryzygomatomys spinosus guiara* (Brandt 1835) — *Echimyidae* +

62 "Rato-catita" ..... *Mesomys didelphoides* (Desmarest 1817) — *Echimyidae* (!?)

63 "Rato-da-taquara" ..... *Kannabateomys a. amblyonyx* (Wagner 1845) — *Echimyidae*

64 Preá ..... + *Cavia a. aperea* Erxleben 1777 — *Caviidae* +

64 Preá ..... *Cavia fulgida* Wagler 1831 — *Caviidae*

65 Cobáia ..... *Cavia porcellus* (Lin. 1758) — *Caviidae*

66 Capivara (22) + *Hydrochaeris h. hydrochaeris* (Lin. 1766) — *Caviidae* +

67 Cutia parda (23) + *Dasyprocta a. aguti* (Lin. 1766) — *Dasyproctidae* +

68 Cutia vermelha ..... *Dasyprocta a. azarae* Lichtenstein 1823 — *Dasyproctidae*

69 Paca (24) + *Agouti p. paca* (Lin. 1766) — *Dasyproctidae* +

70 Ouriço-cacheiro ..... *Coendou p. prehensilis* (Lin. 1758) — *Erethizontidae*

70 Ouriço-cacheiro ..... + *Coendou spinosus nigricans* (Brandt 1835) — *Erethizontidae* +

70 Ouriço-cacheiro ..... *Coendou i. insidiosus* (Kuhl 1820) — *Erethizontidae*

71 Ratinho-do-cacau ou ratinho-praga ..... + *Oryzomys nigripes* (Desmarest 1819) — *Cricetidae* +

72 Ratinho-do-mato ..... + *Oryzomys capito intermedius* (Leche 1886) — *Cricetidae* +

73 Quiara ou rato-d'água ..... + *Nectomys squamipes olivaceus* Hershkovitz 1944 — *Cricetidae* +

74 Rato-de-árvore ..... *Rhipidomys m. mastacalis* (Lund 1841) — *Cricetidae*

75 Rato-do-mato ..... *Thomasomys dorsalis collinus* (Thomas 1917) — *Cricetidae* +

75 Rato-do-mato ..... *Thomasomys dorsalis sublineatus* (Thomas 1903) — *Cricetidae*

76 Rato-do-mato ruivo ..... *Phaenomys ferrugineus* (Thomas 1894) — *Cricetidae*

77 Rato-do-mato laranja ..... + *Rhagomys rufescens* (Thomas 1886) — *Cricetidae* +

78 Rato-do-chão ..... + *Akodon arviculoides cursor* (Winge 1888) — *Cricetidae* +

79 Rato-da-serra ..... *Akodon serrensis leucogula* Mir. Ribeiro 1905 — *Cricetidae*

80 Rato-do-chão ..... + *Akodon n. nigrita* (Lichtenstein 1830) — *Cricetidae* +

81 Rato-toupeira (25) *Oxymycterus hispidus quaestor* Thomas 1903 — *Cricetidae*

81 Rato-toupeira ..... *Blarinomys breviceps* (Winge 1887) — *Cricetidae*

82 Rato-de-palmatória ..... *Wiedomys pyrrhorhinos* (Wied 1821) — *Cricetidae*

83 Rato-d'água ..... *Holochilus brasiliensis leucogaster* Brandt 1835 — *Cricetidae*

ORDER: *CHIROPTERA*

84 Morcêgo ..... *Rhynchonycteris naso* (Wied 1820) — *Emballonuridae*

84 Morcêgo ..... + *Saccopteryx bilineata* (Temmincki 1838) — *Emballonuridae* +

85 Morcêgo-vampiro (26) + *Desmodus r. rotundus* (Geoffroy 1810) — *Desmodontidae* +

85 Morcêgo-vampiro ..... + *Diaemus youngi* (Jentink 1893) — *Desmodontidae* +

85 Morcêgo-vampiro ..... + *Diphylla e. ecaudata* Spix 1823 — *Desmodontidae* +

86 Morcêgo ..... + *Molossops t. temminckii* (Burmeister 1854) — *Molossidae* +

86 Morcêgo ..... + *Tadarida brasiliensis* (I. Geoffroy 1824) — *Molossidae* +

86 Morcêgo ..... + *Eumops abrasus* (Temmincki 1827) — *Molossidae* +

86 Morcêgo ..... + *Eumops p. perotis* (Schinz 1821) — *Molossidae* +

86 Morcêgo ..... + *Promops n. nasutus* (Spix 1823) — *Molossidae* +

86 Morcêgo ..... + *Dasypterus ega argentinus* Thomas 1901 — *Vespertilionidae* +

86 Morcêgo ..... + *Myotis n. nigricans* (Schinz 1821) — *Vespertilionidae* +

86 Morcêgo ..... + *Myotis albescens* (Geoffroy 1806) — *Vespertilionidae* +

86 Morcêgo ..... + *Eptesicus b. brasiliensis* (Desmarest 1819) — + *Vespertilionidae*

86 Morcêgo ..... + *Histiotus velatus* (I. Geoffroy 1824) — *Vespertilionidae* +

86 Morcêgo ..... *Lasiurus borealis blossevillii* (Lesson et Garnot 1826) — *Vespertilionidae*

86 Morcêgo ..... *Natalus s. stramineus* Gray 1838 — *Natalidae*

86 Morcêgo ..... + *Furipterus horrens* (F. Cuvier 1828) — *Furipteridae* +

86 Morcêgo ..... *Micronycteris minuta* (Gervais 1855) — *Phyllostomidae*

86 Morcêgo ..... + *Lonchorhina aurita* Thomas 1863 — *Phyllostomidae* +

86 Morcêgo ..... *Macrophyllum macrophyllum* (Wied 1821) — *Phyllostomidae*

86 Morcêgo ..... + *Mimon bennettii* (Gray 1838) — *Phyllostomidae* +

86 Morcêgo ..... — + *Mimon crenulatum* (Geoffroy 1810) — *Phyllostomidae* +

86 Morcêgo ..... + *Mimon picatum* Thomas 1903 — *Phyllostomidae* +

86 Morcêgo ..... + *Phyllostomus h. hastatus* (Pallas 1767) — *Phyllostomidae* +

86 Morcêgo ..... *Chrotopterus auritus australis* Thomas 1861 — *Phyllostomidae*

86 Morcêgo ..... + *Anoura c. caudifera* (Geoffroy 1818) — *Phyllostomidae* +

86 Morcêgo ..... + *Anoura g. geoffroyi* Gray 1838 — *Phyllostomidae* +

86 Morcêgo ..... + *Lonchophylla mordax* Thomas 1903 — *Phyllostomidae* +

86 Morcêgo ..... + *Rhinophylla pumilio* Peters 1865 — *Phyllostomidae* +

86 Morcêgo ..... + *Uroderma bilobatum* Peters 1866 — *Phyllostomidae* +

86 Morcêgo ..... + *Vampyrops lineatus* (Geoffroy 1810) — *Phyllostomidae* +

86 Morcêgo ..... + *Vampyressa pusilla* (Wagner 1843) — *Phyllostomidae* +

86 Morcêgo ..... + *Chiroderma doriae* Thomas 1891 — *Phyllostomidae* +

86 Morcêgo ..... + *Artibeus l. lituratus* (Olfers 1818) — *Phyllostomidae* +

ORDER: *MARSUPIALIA*

87 Gambá ou mucura ..... + *Didelphis a. azarae* Temmincki 1825 — *Didelphidae* +

87 Gambá ou mucura ..... + *Didelphis marsupialis aurita* Wied 1826 — *Didelphidae* +

88 Catita ou guaiquica ..... + *Marmosa c. cinerea* (Temmincki 1824) — *Didelphidae* +

89 Jupati ..... + *Monodelphis scalops* (Thomas 1888) — *Didelphidae* +

89 Jupati ..... + *Monodelphis americana theresa* Thomas 1921 — *Didelphidae* +

90 Cuica d'água ..... + *Chironectes m. minimus* (Zimmermann 1780) — *Didelphidae* +

91 Cuica (27) + *Caluromys philander dichrurus* (Wagner 1842) — *Didelphidae* +

92 Jupati ..... + *Metachirus nudicaudatus myosurus* (Temmincki 1825) — *Didelphidae* +

92 Jupati ..... *Monodelphis touan rubidus* (Thomas 1888) — *Didelphidae*

92 Jupati ..... *Monodelphis dimidiata* (Wagner 1847) — *Didelphidae*

94 Catita ..... + *Marmosa incana* (Lund 1841) — *Didelphidae* +

Cuica ..... + *Philander opossum quica* (Temmincki 1825) — *Didelphidae* +

Obs.: — "Baleia-de-bico", (*Mesoplodon gervaisi*), embora não sendo as-

Legend: 1 -- Order: Cetacea; 2 -- Porpoise; 3 -- porpoise; 4 -- pilot porpoise; 5 -- dolphin; 6 -- killer whale; 7 -- killer whale; 8 -- Cuvier whale; 9 -- sperm whale; 10 -- dwarf whale; 11 -- royal whale; 12 -- dwarf finback whale; 13 -- finback whale; 14 -- "Finback" rorqual; 15 -- Blue finback whale; 16 -- Rorqual or humpback whale; 17 -- black tapir; 18 -- white-collared peccary; 19 -- white-lipped peccary; 20 -- brocket deer; 21 -- prairie deer; 22 -- hare-like rodent; 23 -- great anteater; 24 -- little anteater; 25 -- sloth; 26 -- collared sloth; 27 -- small armadillo; 28 -- armadillo; 29 -- pindoba armadillo; 30 -- rawhide armadillo; 31 -- giant armadillo; 32 -- capuchin or saki monkey; 33 -- white-headed capuchin; 34 -- capuchin; 35 -- red howler; 36 -- marmoset; 37 -- black-headed marmoset; 38 -- spider monkey; 39 -- capuchin monkey; 40 -- cougar; 41 -- jaguar; 42 -- spotted cat; 43 -- spotted cat; 44 -- jaguar; 45 -- jaguar; 46 -- forest dog or wolf; 47 -- crab-eating racoon; 48 -- brown coati; 49 -- kinkajou; 50 -- otter; 51 -- giant river otter; 52 -- tayra; 53 -- small ferret; 54 -- large ferret; 55 -- conepate; 56 -- walrus; 57 -- sea lion; 58 -- chipmunk; 59 -- toad; 60 -- hedgehog; 61 -- river mouse; 62 -- house mouse; 63 -- small rice rat; 64 -- cavy; 65 -- guinea-pig; 66 -- water cavy; 67 -- Brown agouti; 68 -- Red agouti; 69 -- spotted cavy; 70 -- coendou; 71 -- cocoa mouse; 72 -- forest mouse; 73 -- water rat; 74 -- tree rat; 75 -- forest rat; 76 -- red forest rat; 77 -- orange forest rat; 78 -- plains rat; 79 -- mountain rat; 80 -- plains rat; 81 -- ground mole [rat]; 82 -- palm rat; 83 -- water rat; 84 -- bat; 85 -- vampire bat; 86 -- bat; 87 -- opossum; 88 -- mouse; 89 -- jupati; 90 -- water opossum; 91 -- opossum; 92 -- jupati; 93 -- mouse; 94 -- opossum

Note: The "humped back whale" (Mesoplodon gervaisi) has not been reported along the coast of South America but one of these animals was encountered at the Island of Trinidad; this leads us to assume that it can be found in the northern and eastern waters of South America (Cabrera, 1961).

The cougar (Panthera o. onca) was located just once, in 1959, on the sand bar of Jacarepagua, GB, near the Camorim lagoon, at night; this animal was observed crossing the highway of the Bandeirantes, headed for the mountains and the forest of Camorim; the observation was made by J.P. Lanna Sobrinho, a botanist assigned to the CPFCN.

As for the Coati (Nasua nasua), we can say that the South American coatis are representatives of a single species with two chromatic phases: one dark brown and the other reddish-orange; in some cases we have marked tendency toward black. We were also able to observe albino animals here in the zoo at Guanabara which has one such animal (1963). The distinction is always difficult to make between the various subspecies and must be made with great care because these subspecies are not very well defined.

The guinea-pig (Cavia porcellus) is used of course as a laboratory animal; it is found all over the world today, in domesticated forms, as well as in well-selected breeds for the laboratory uses. It may have existed here in a wild condition since Lund found fossils of this species in the Sanga Lagoon, MG, and the typical locality would appear to be Pernambuco.

The Yaguarundi (Felis yagouaroundi) is found in two color variations: black and orange-yellow.

Bibliography

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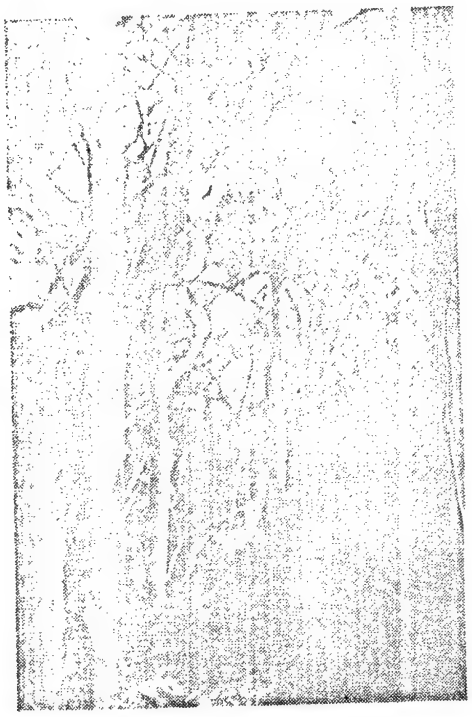
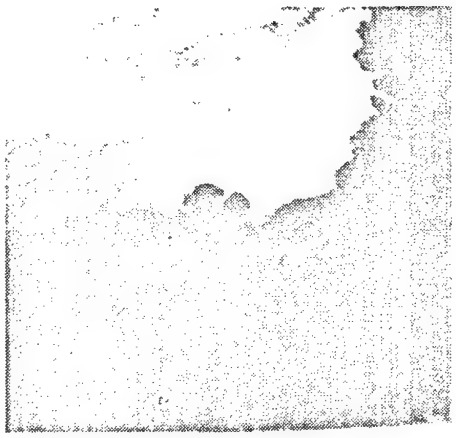
FIGURE APPENDIX

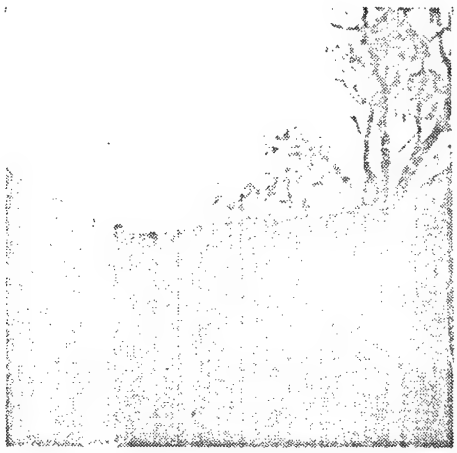
Tropical, humid, litoral forest, open, secondary -- region of Teresopolis, Rio de Janeiro



Typical woodland savanna vegetation: habitat of varied fauna

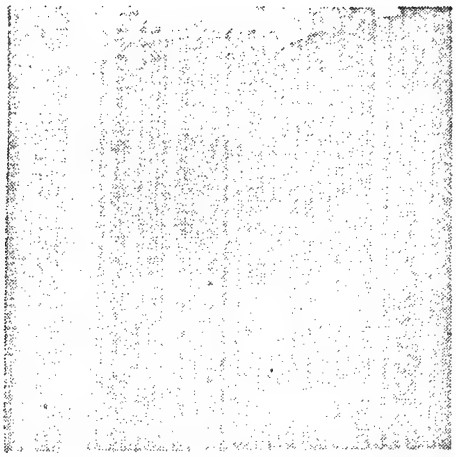


View of prairie with typical woodland savanna in background

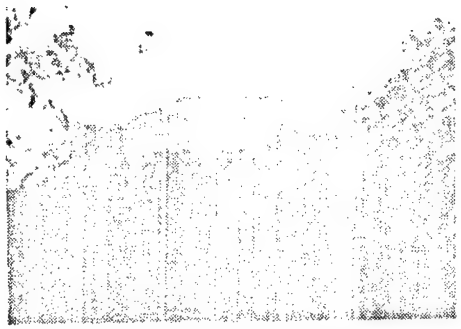


Gavea Pequena, GB; view of Tio de Janeiro countryside

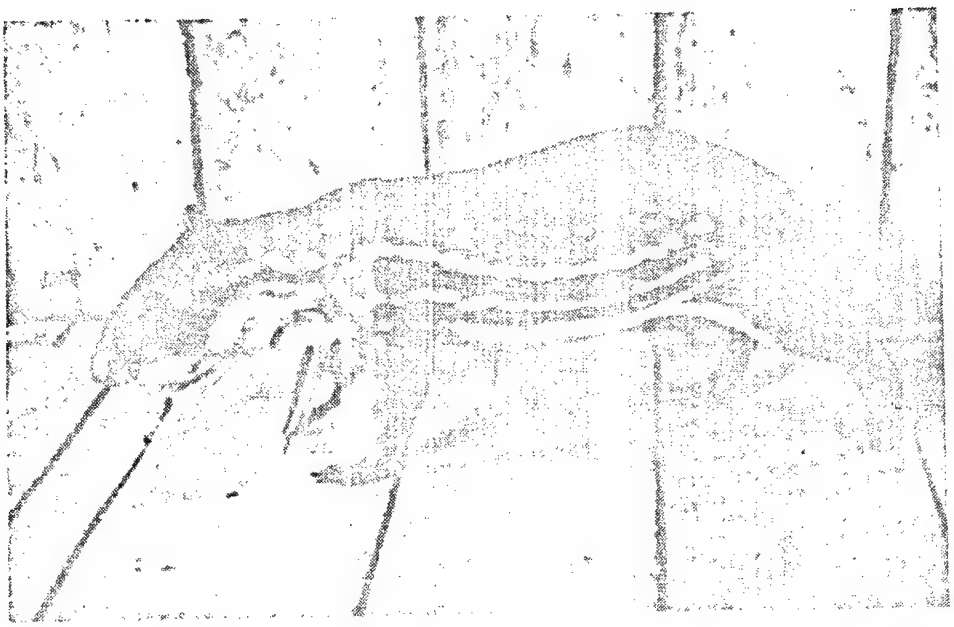
Mount region in the state of Rio de Janeiro, along highway to the Araras mountain range, showing the rugged countryside which is so common in Brazil



Region of Pedra Branca, in the massif of Gangu-Jacarepagua, GB, showing the predominant terrain features found in the southeastern part of Brazil



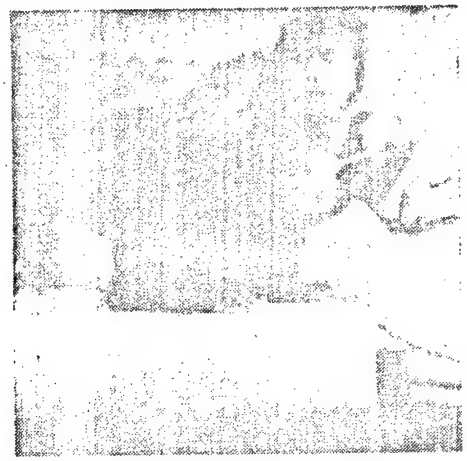
View of tropical mountain forest (Carioca massif)



The spotted cavy (Agouti paca). This is a typical ambulatory rodent which lives in the forests and fields, near rivers and lagoons where it moves about mostly at night, leaving its hole in search of forest fruit, seeds, roots, etc. It is quite a bit larger than the agouti as such in whose family it has currently been placed on the basis of the modern categorization systems. Its geographic distribution includes Central and South America, to the east of the Andes. (Photo through the kindness of Dr Joao Moojen.)

Scrub woodland here (Mazama gouazoubira); inhabits the scrub woodland and fields in a major portion of South America, to the east of the Andes. Feeds on grass, plants, small fruit, usually foraging during moonlight. This is a species of simple-hoof deer.

River mouse (Euryzigomatomy spinosus) - lives in the eastern and southeastern part of Brazil, in places covered by tall grass and shrubbery, in woodland savanna, not far from water sources. Has digging habits, indicated by well-developed teeth and short tail. (Photo through kindness of Dr. Joao Moojen.)

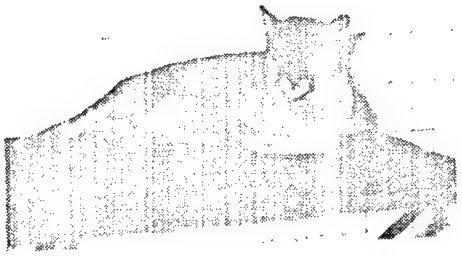


Capuchin monkey (Cebus apella) - found from the northern portion of South America all the way to the eastern and central southern portions of this continent where it lives in forest zones, in the plains and highlands and mountains, up to an elevation of 1,500 m; this is a very gregarious animal living on fruit, little birds, eggs, little vertebrates, insects, spiders, larvae, and worms. Typically omnivorous.

Sloth (Bradypus infuscatus brasiliensis) - lives in the southeastern part of Brazil, in humid forests and woodland savanna, ciliary forests, and sand bar vege-

tation. Also found in mountain forests. Mainly eats leaves of the trumpet tree (Cecropia), forest fruits and leaves of other plants. This is a rather solitary animal, moving very slowly, rolling up around branches, looking like a white-throated oven bird (Furnarius); another unusual feature here is that this animal is found, in a certain state of lethargy, after thunderstorms, which is believed to be due to the blows inflicted upon the animal by the storm. (Photo through kindness of Dr. Joao Moojen.)

Great anteater (Myrmecophaga tridactyla) - lives in the wooodland savanna and prairies, sometimes penetrating into the forests and woods, where it eats termites and ants which it picks up with its powerful sickle-shaped claws in its hind legs; this is a solitary animal and lathough its populations are balanced, it is not abundant anywhere. It is distributed over the eastern slopes of the Andes on the South American continent. (Photo L. H. Cordelier.)

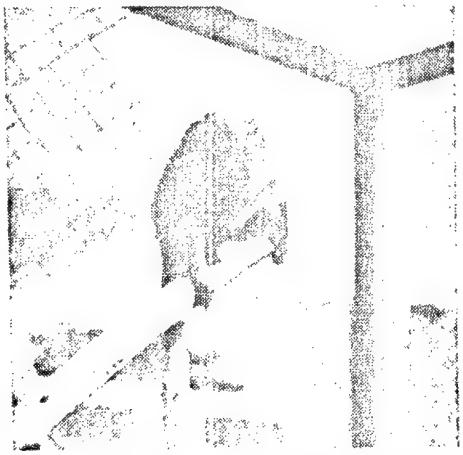


Cougar (Felis concolor) - distributed all over America, from Canada down to Patagonia. This is the second-largest feline in this hemisphere and it is the biggest cat in the world, in terms of size and strength. It lives in the mountains, plateaus, prairies, plains, forests, open woods, woodland savannas,

etc., at various elevations, from sea level up. It attacks any mammal the size of a horse, as well as birds but does not attack man unless it is defending its young or when an attempt is made to capture it. It comes out mostly at night, like all of the other cats, but we can also spot it in the early, foggy morning and at sunset. (Photo through kindness of Enciclopedia Infantil Brasileira [Brazilian Children's Encyclopedia])

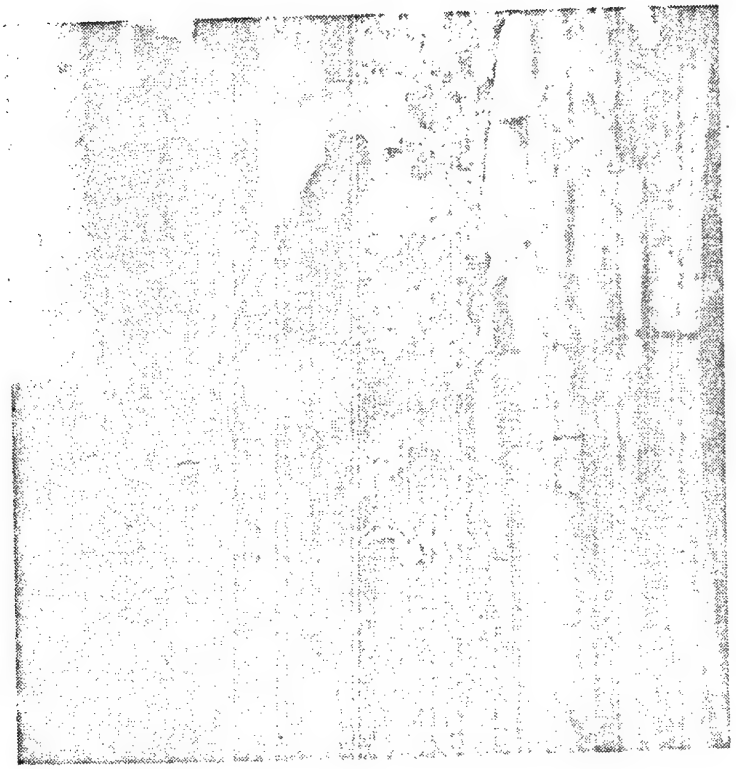
The Coati (Nasua nasua) - distributed all over Central and South America, in forest zones, in plains and plateus and mountain ranges, where it moves about in more or less numerous packs; it is up around the clock and can be found on the ground and high up in the trees where it looks for food in the form of honey, insects, larvae, worms, small birds and eggs, small vertebrates, fruit, seeds, etc., since this is a typically ommivorous species.

The giant armadillo (Priodontes giganteus) - distributed in eastern part of South America, spotted near water sources, in forests and woods along edge of woodland savanna vegetation where it digs its holes; this is a nighttime animal, like all of the armadillos, and it is crepuscular; it eats ants, termites, and other insects, larvae, worms, small reptiles, spiders, and carrion; it is the highest of the living armadillos and it is threatened with extinction, which means that it must be given maximum protection. (Photo taken from Selecoes do Reader's Digest [Selections from Reader's Digest])



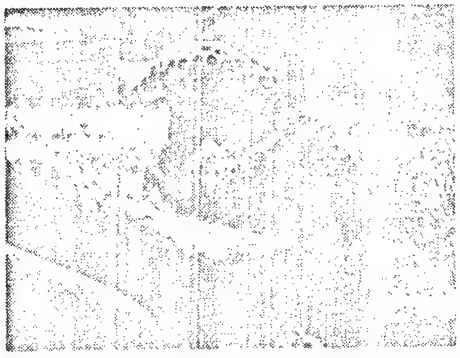
Capuchin monkey (Leontideus rosalia) - distributed throughout the forests in

the southeastern part of Brazil where it moves in small packs, eating fruit, honey, insects, small vertebrates, and eggs.



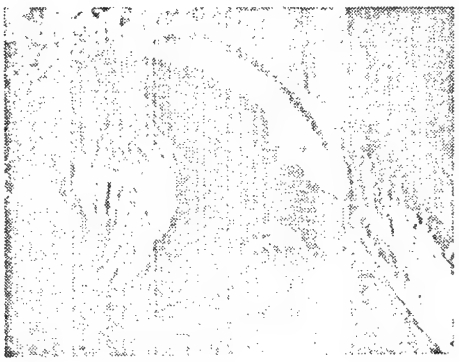
The small anteater (Tamandua tetradactyla) - Lives in the tropical forests and savannas, from the southern part of Mexico all the way to Bolivia and Brazil. This is a tree animal which comes out mostly at night; but it cal alse be encountered early in the morning and at sunset. It eats ants, termites, and bees, and on occasion it will also eat honey. (Photo through kindness of Dr. Joao Moojen.)

The spotted leopard-cat (Felis pardalis) - found from the northern part of Mexico and southern part of the United States all the way down to South America where they live in forests, plains, highlands and mountain ranges, wherever there is a thick vegetation, as well as in the woodland savannas, forests and woods; they usually come out at night and they are crepuscular, just like cats in general; they eat small mammals, birds, eggs, reptiles, and they are essentially tree animals. (Photo through kindness of Enciclopedia Infantil Brasileira.)

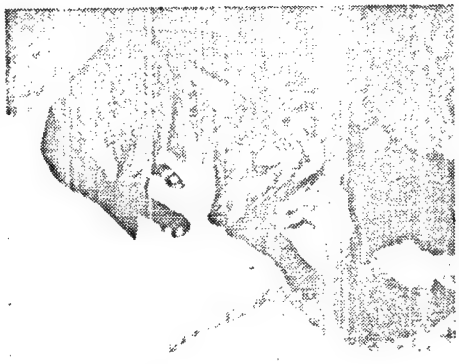


The jaguar (Panthera onca) - this is the biggest and strongest American cat whose geographic distribution extends from the southern part of Texas all the way down to Patagonia, where it forms a number of subspecies. In Brazil we only have two geographic groups: one in the Pantanal [swamp country], the so-called canguçu, and the other one in the rest of Brazil, the "pintada" which is quite a bit smaller. In the western hemisphere, this species represents

the same thing as the leopard in the Old World and Africa because they are very closely related species. The jaguar lives in the forests and woods, in the savannas, in the prairies and grass country, in mountain ranges, and even invades farm country where he will attack animals, including cows, sheep, and goats; however, it will also attack larger birds, reptiles, and sometimes it will even eat fish; it is also known to eat small alligators. (Photo through kindness of Enciclopedia Infantil Brasileira.)

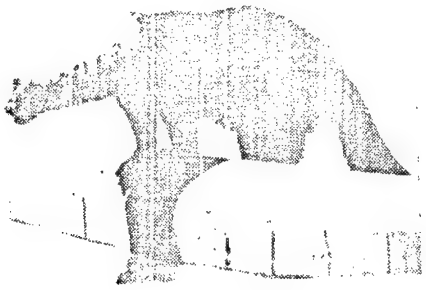


Skunk (Conepatus chinga suffocans) - distributed in Southeastern part of Brazil, Uruguay, Northeastern part of Argentina, and southern and southeastern part of Paraguay. Lives in woods and open areas, such as shore vegetation along sand bars and clumps of forests; this is a nighttime animal which has a natural immunity against bites of certain rattlesnakes; it can therefore fight against poisonous snakes, except the coral snakes whose poison is fatal to it. It eats insects, larvae, small vertebrates, mainly poisonous snakes, birds and eggs, cactus fruit, honey, worms, etc. Because it is a snake-eating animal, it must be protected and should even be kept in the vicinity of human settlements. In the perianal region, it has a gland which secretes a nauseating liquid which it uses for defense, ejaculating this secretion whenever attacked. (Photo through kindness of Enciclopedia Infantil Brasileira.)



The forest dog (Cerdocyon thous) - distributed all over South America, with the exception of the Andes; lives in open forests, woodland savanna, fields, mountain forests, where it hunts small rodents, birds, insects, lizards,

frogs, and crabs; it also eats fruits, turtle eggs, etc.; it preferably comes out at night although it has been observed on cloudy days on occasion. (Photo through kindness of Enciclopedia Infantil Brasileira.)



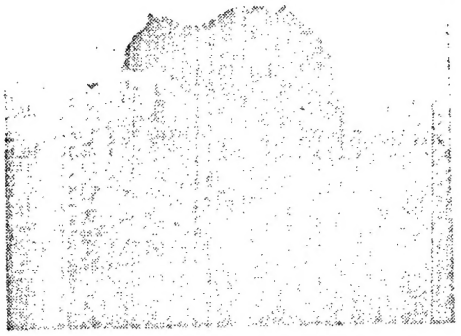
Tayra (Eira barbara) - lives in the forest zones of Central and South America, from Mexico down to Argentina, including the Island of Trinidad. They travel in pairs [couples] or in family groups and they operate both at night and during the day. During the day they are seen most frequently in the morning. They can run, swim, or dig very well. They eat small vertebrates and we have a report of an attach by a tayra on a Mazama deer. They also eat honey, fruits, especially bananas. (Kindness of Enciclopedia Infantil Brasileira.)

Walrus (Mirounga leonina) - lives along eastern waters washing the southern portion of South America, Australia, New Zealand, South Georgia; here with

two species, we have the genus M. leonina and M. angustirostris, with the former, the eastern, and the latter, the southern walrus representing the largest of the pinnipedia known today; the females are almost half the size of the males. On occasion they can be found along the shore of Rio de Janeiro, for instance, during the winter, sometimes coming in with the currents of the Antarctic Ocean, where these animals have been sighted four times and where one of them was captured. (Photo through kindness of O Globo [The World], Rio.)

Water cavy (Hydrochaeris hydrochaeris) - this is the biggest of the living rodents; distributed all over South America, with the exception of the Andes, sometimes extending as far as the Isthmus of Panama. Lives in forests and woods, swampy fields, river banks, lagoons, etc, where it seeks refuge when it is hunted or wounded; it is an excellent swimmer and diver; it has an interdigital membrane which is very well developed for swimming. We can therefore say that it lives in semi-aquatic areas. Its fat yields an oil with medicinal properties; this is called "water cavy oil" and the skin of this animal can replace that of the chamois (?). It is believed to be the transmitter of the cattle fever virus because it uses the same drinking places as cattle. Its principal enemy is the great water-snake, the Eunectes; both of these animals preferably stay near water bodies. (Photo L. H. Cordelier.)

The dolphin (delphinus delphis), commonly found in the temperate and tropical ocean. It is known also as the common dolphin. It comes in groups, jumping out of the water and showing its back. It can be as long as 3 meters. It eats smaller and medium-sized fish, small mollusks, etc. It is an enemy of the sharks and usually comes off best in any encounter with smal l sharks. (Photo through kindness of Enciclopedia Infantil Brasileira.)

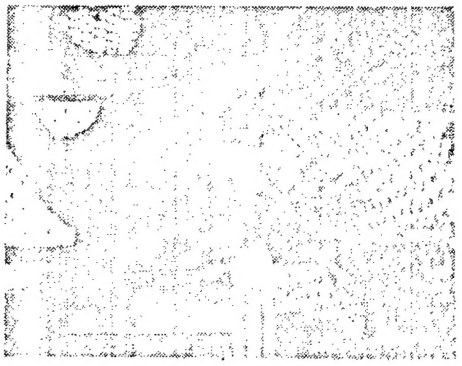


The brown agouti (Dasyprocta aguti) - its geographical distribution extends from the southern part of Amazonia, through the eastern part of Brazil down to Rio de Janeiro, where it lives in forests and woods; it moves in pairs or small groups, and eats fruit, seeds, woots, and bulbs; it is mainly a nighttime animal but it can also be found during the day, early in the morning or at sunset.

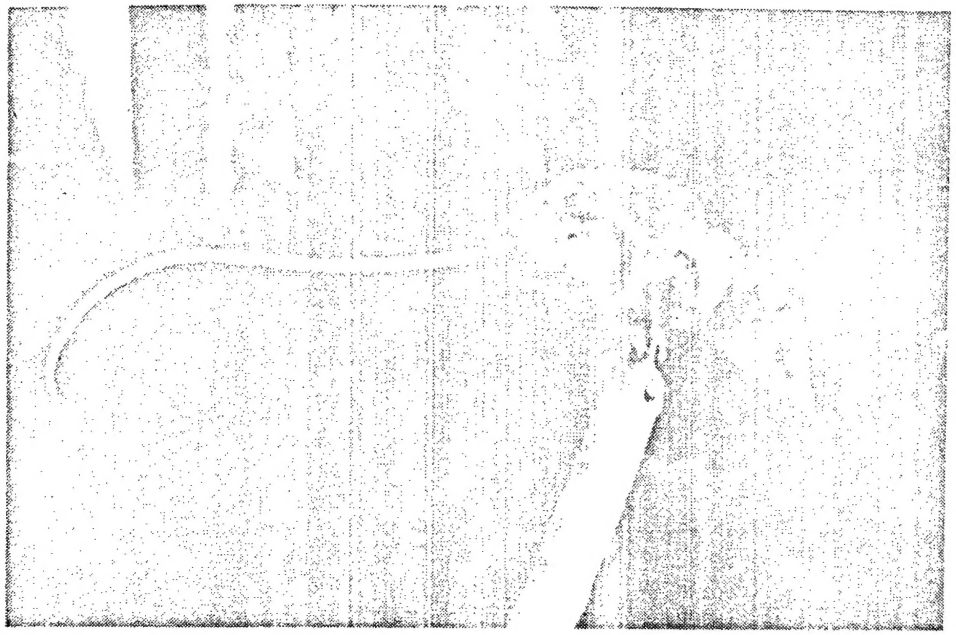
The jupara [kinkajou] (Potos flavus) - found in the forest regions of Central and South America; about the size of a small cat; essentially a nighttime

animal; eats fruits, seeds, and insects, honey, small mammals, birds, eggs, larvae; never seen during the daytime when it sleeps deeply; this animal is very well adapted to life in the trees. In Central America it is called "kinkajou" (through the kindness of the Enciclopedia Infantil Brasileira).

Ground mole rat (Blarinomys breviceps) - found in eastern Brazil where it was discovered at Santa Lagoon, MG, and Teresopolis, RJ; lives in dense rain forest, near the tops of hills and mountains, about 800 m elevation, or in similar places and less humid areas, where it digs its holes; perfectly equipped for this kind of life. (Photo-drawing from Moojen, J., Os Roedores de Brasil, I. N. L., 1952.)

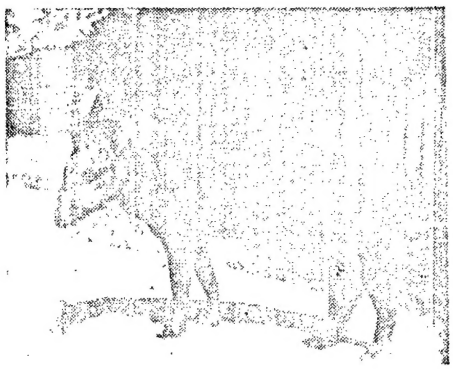


Crab-eating racoon (Procyon cancrivorous) - This is a South American form of this type of animal; encountered from the interior of the continent all the way to the eastern part. Lives in savanna, along the shoreline vegetation of the sand bars, in the forests, mountains and plains, lagoons, where it eats crabs and similar animals, mollusks and small vertebrates. It usually likes to stay near the water and usually comes out at night; occasionally will also eat honey, fruit, and insects; this is an excellent tree animal. (Photo through kindness of Enciclopedia Infantil Brasileira.)



Mouse (Marmosa incana) - found in southeastern part of Brazil, in forest zones,

prairies, usually a solitary animal, coming out at night; excellent tree animal, does not have marsupial pouch; eats bananas and other fruits, insects, small rodents and birds, eggs, and tiny reptiles. (Photo through kindness of Dr Joao Moojen.)



Vampire bat (Desmodus rotundus) - distributed from Mexico down through South America where it lives in arid and humid, tropical and subtropical regions. Essentially a bloodsucker, goes out at night looking for animals, such as horses, cattle, goats, poultry, and even man; it makes a small incision and then sucks the blood through it; it can thus transmit serious infectious diseases, such as hoof and mouth disease, hydrophobia, and other cattle diseases, sometimes even vampire bats are the victims. Fighting is an urgent necessity to them. (Photo-drawing taken from Ihering, R. von, Da Vida dos Nossos Animais [On the Life of Our Animals], 1953.)

The black tapir (Tapirus terrestris) - lives in fields, woodland savanna, and forests of South America, in the Central-Eastern regions of the continent; this is a solitary animal. When in danger, it tries to excape to the water because it is an excellent swimmer and spends most of its life in the water. It has a very fine sense of smell and a very good sense of hearing and it is therefore extremely difficult to capture this animal. It emits a very fine and soft whistle, quite in contrast to its size, resistance and strength. It is today quite rare in certain regions and it may no longer be hunted because it is in danger of extinction. (Photo by Edmundo Dantes P. da Silveira.)

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